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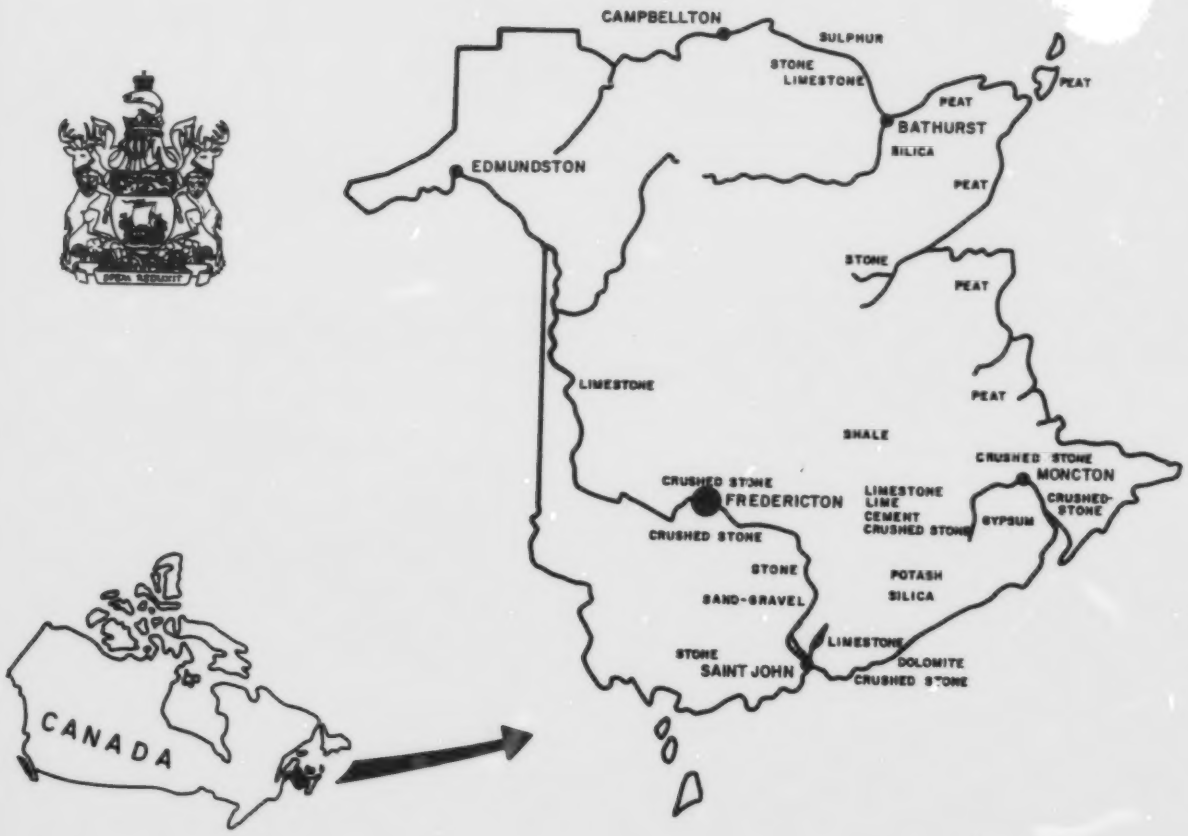
Industrial Mineral Resources of New Brunswick - 1988



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PRELIMINARY REPORT ON THE INDUSTRIAL MINERAL RESOURCES OF NEW BRUNSWICK - 1988

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ABBREVIATIONS USED IN TEXT

m	metre (1 m equals 3.280 84 feet)
m^2	square metre
km	kilometre (1 km equals 0.621 371 mile)
km^2	square kilometre
ha	hectare (1 ha equals 2.741 054 acres)
t	tonne (1 t equals 1.102 311 short tons)
tpa	tonnes per year

INDUSTRIAL MINERAL RESOURCES OF NEW BRUNSWICK

Abstract

In 1988, industrial mineral production accounted for a 31% share of the total value of mineral production in New Brunswick. The prelimirary figure for the value of industrial minerals produced (including cement, lime, and various aggregates) in the Province is about $251 000 000 (Cdn) in 1988, compared to $197 000 000 in 1987. This increase of twenty-two (22) percent is the result of greater potash and peat production. The mining of potash near Sussex has been instrumental in establishing industrial minerals as a major contributor to the Province's mineral wealth. Other industrial minerals produced in New Brunswick include silica, peat, limestone, gypsum, sulphur, salt, sand, gravel, crushed stone, dimension stone, and brick shale.

Résumé

En 1988 la production de minéraux industriaux était 31% de la valeux totale de la production minerale totale en Nouveau-Brunswick. Le chiffre préliminaire pour la valeur des minéraux industriels produits (y compris le ciment, le calcaire, et aggrégats divers) dans la Province est environ $251 000 000 (Cdn.) en 1988, vis à vis $197 000 000 en 1987. Cette augmentation par vingt-deux (22) pour cent resulte d'une production aggrandie de potasse et de tourbe. L'extraction de potasse proche de Sussex a été important à établissement les minéraux industriaux comme contribution majeure aux richesses minérales de la Province. D'autres minéraux industriaux produits en Nouveau-Brunswick comprennent la silice, la tourbe, le calcaire, le gypse, le sulfure, le sel, le sable, le gravier, pierre concassé, pierre de construction, et ardoise à brique.

1.0 INTRODUCTION

Most would associate mineral development in New Brunswick with extensive base-metal mining operations situated in the northern part of the province. However, few people seldom either realize or simply take for granted a category of mineral commodities they see and use everyday - mineral commodities that are directly associated with virtually every activity of our modern life style - eating, wearing apparel, housing, transportation, arts and entertainment etc. These substances referred to as "industrial minerals", are the "workhorse minerals", upon which much of our economy and personal well being depend.

The apparent low profile of most industrial minerals is perceived to be a function of the numerous stages of transformation these substances undergo in making them a suitable consumer item. Unlike metals which are easily recognizable in most consumer goods, industrial minerals are often camouflaged in compounds that in most cases entirely mask their origin. The next time you pick up something made of paper, plastic or even rubber, just take a moment and consider these particular products would not be possible to manufacture cost effectively or would vary considerably in quality if it were not for industrial mineral derived products.

This booklet not only describes the importance of industrial minerals in todays society but also provides a brief synopsis of those industrial mineral commodites presently produced in New Brunswick, those which have been produced in the past and those which may deserve future attention.

2.0 NEW BRUNSWICK'S MINERAL INDUSTRY

New Brunswick's mineral industry began in the early 1700s with the production of coal, gypsum and grindstones. In the middle to late 1800s, hydrocarbons, copper, antimony, iron, manganese, limestone, and building stone achieved prominence. Oil, gas, coal, gypsum and peat moss were the mainstays of production until 1964, when base metals (lead, zinc and copper) began their substantial contribution to the Province's mineral heritage. Since 1983, potash, salt, and gold have added to the diversity and strength of the Province's mineral industry.

The mineral industry is a major contributor to New Brunswick's economy, and one of its fastest growing industries. Its growth is reflected in the total value of minerals produced, which has increased from $11 700 000 in 1953 to about $850 000 000 in 1988. The industry directly employs more than 4500 people and contributes approximately 8% to the Province's gross domestic product. At the present time, metals (including zinc, silver, lead, copper, gold, bismuth, cadmium, and antimony) contribute about 65% to the total value of minerals produced. The balance of mineral production is accounted for by industrial minerals (nonmetals and aggregates) and mineral fuels (coal, natural gas and petroleum).

By the year 2000, the value of mineral production in New Brunswick may approach $1 000 000 000 and direct employment in the mining industry could range from 5000-6000 people with an equivalent number employed in related service, supply, and transportation industries.

When compared to other provinces and territories, New Brunswick continues to make a significant contribution to the quantity and diversity of minerals produced in Canada. The Province's 1988, four (4 per cent) contribution to the total value of minerals produced in Canada would at first glance seem small, however, it is important to realize that New Brunswick mining operations account for over 90% of the nation's bismuth production; 30% of the nation's peat production; approximately 20% of the nation's antimony, lead and zinc production and about 12% of total potash and silver production.

Excluding production of fuel minerals (oil, natural gas and coal) the Province ranks first in dollar value of minerals produced per land area and sixth in dollar value of minerals per capita.

Since its early beginnings, New Brunswick's mineral industry has shown signs of steady growth and diversification. Recent discoveries of gold, silver, base metals, limestone, dolomite and silica have been made, and a third potash deposit may be developed in the southern part of the Province. There remains potential for continued growth in all segments of the industry because of the diversity of minerals available, recent advancements in process technology, and a general improvement in consumption of various mineral products.

3.0 INDUSTRIAL MINERALS ..... HOW SIGNIFICANT ARE THEY?

Industrial minerals can be defined as any nonmetallic, non-fuel rock, mineral or other naturally occurring earth substance extracted and processed for an industrial end use. Such a term is also commonly applied to that proportion of metallic ores consumed in nonmetallurgical applications. By definition, industrial minerals therefore constitute an extensive list of mineral commodities - a list which includes everything from ordinary rock materials such as sand and gravel, crushed stone and building stone to organically derived materials like peat moss.

Apart from its final industrial end-use, diversity is perhaps the most common denominator of all industrial minerals and is probably their most outstanding feature. The diverse nature of these substances is displayed by several differences in: genetic origin, physical and chemical properties, industrial applications, unit values, bulkiness, tradability, mining techniques, processing technology and supply/demand balances.

As stated in the introduction, the ordinary consumer is frequently not aware of the vital role performed by industrial mineral as important components of most manufactured goods. Virtually every durable and non-durable consumer

product made today uses industrial minerals in some form and at some stage of its manufacturing process, either as a process aid (food processing) or as input material in the manufacturing of intermediate products (gypsum in wallboard).

The important contribution made by industrial minerals to society can be measured by comparing their global production levels and their total production values during the early 1980s, with similar figures for metallic ores, precious minerals (gems) and solid fuel minerals (oil and gas excluded) These comparisons, are illustrated in Figure 3.1 as a percentage share of the total quantity of solid mineral commodities produced in the world in 1983. As indicated industrial minerals represent the "lions share", at 72 percent. Similarly, industrial minerals maintain the largest percentage share of total output value , surpassing the value of metals by almost a 3:1 margin.

Comparing individual solid mineral commodities ranked according to their respective position within the top ten produced globally, once again reaffirms the importance of industrial minerals (Figure 3.2). With respect to total production volume, industrial minerals occupy seven (7) of the ten (10) leading minerals produced in the world with sand and gravel taking the number one spot followed by coal. Metals are placed in the 6th position. A comparison of production values reveals industrial minerals and precious minerals (gems etc.) each occupying three (3) positions out of ten (10) with metals and fuel minerals each taking up two (2) positions. Arrangement of mineral commodities by size categories based on world production quantities (Figure 3.3) finds industrial minerals leading in all top five (5) size categories with metals predominating the three lower size catagories.

4.0 INDUSTRIAL MINERALS - AN IMPORTANT PART OF NEW BRUNSWICK'S MINERAL INDUSTRY

In 1988, industrial mineral production accounted for 31% of the total value of Provincial mineral production. Preliminary figures for the value of industrial minerals produced (including cement, lime and various aggregates) was about $251 000 000 (Cdn) in 1988, compared to $197 000 000 in 1987 (Figure 4.1) This increase of twenty-two (22) percent is accounted for by increases in potash and peat production. The mining of potash near Sussex has been instrumental in making industrial minerals a major contributor to the Province's mineral production. Other industrial minerals produced in New Brunswick include silica, peat, limestone, gypsum, sulphur, salt, sand, gravel, crushed stone, dimension stone, and brick shale (Figure 4.2). Barite, graphite, glauberite, phosphate, fluorite, diatomite, beryl, kaolin, manganese, zeolite and titanium are among some of the nonmetallics known to occur but are not presently being developed. As shown in figure 4.3, industrial minerals (nonmetals and aggregates) have experienced an average annual growth rate in the order of 15 per cent over the last decade as opposed to 6 per cent for metals. This trend is likely to continue into the 1990's and beyond.

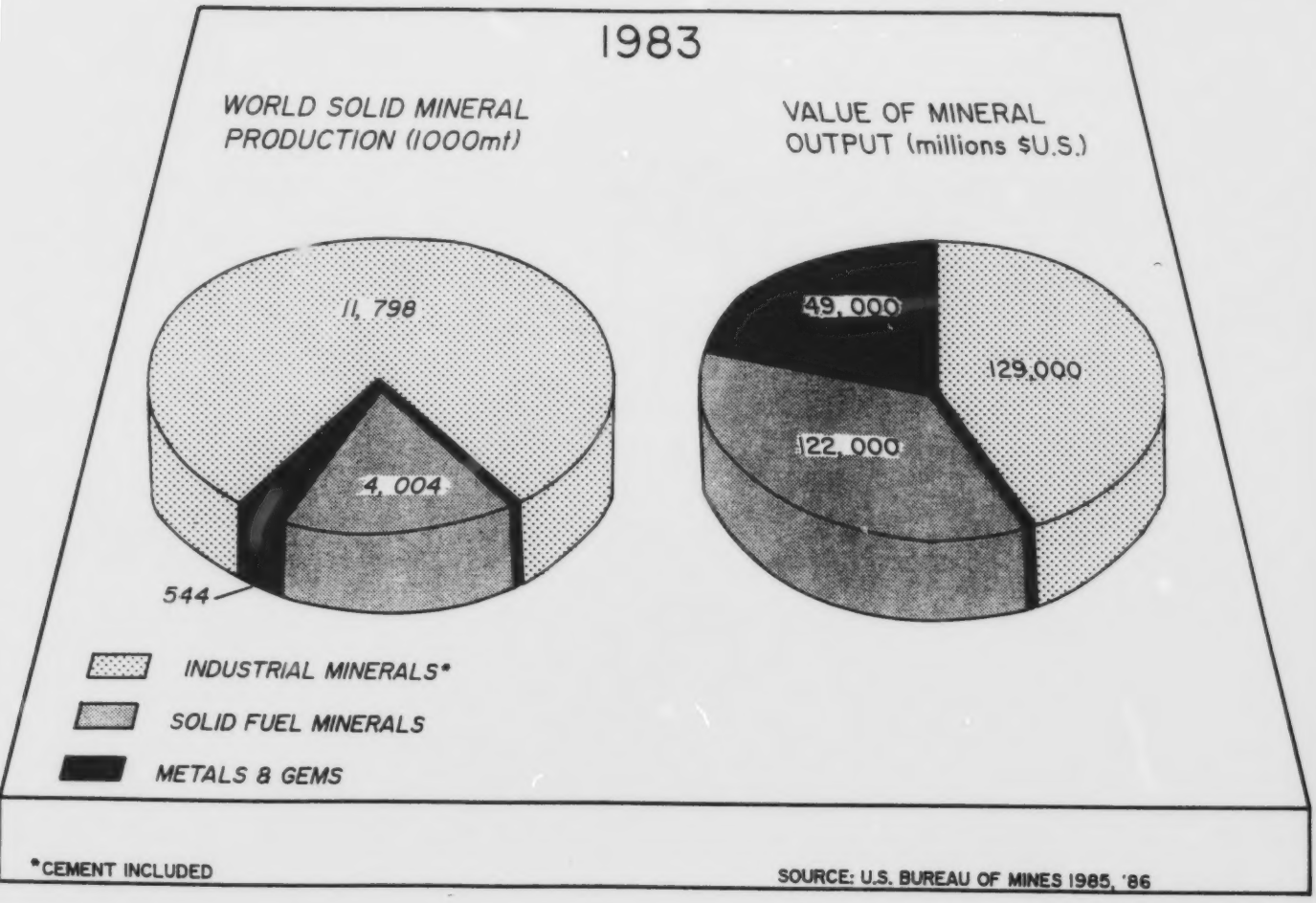


Figure 3.1 Distribution of world solid mineral production and value of output by major mineral category for 1983

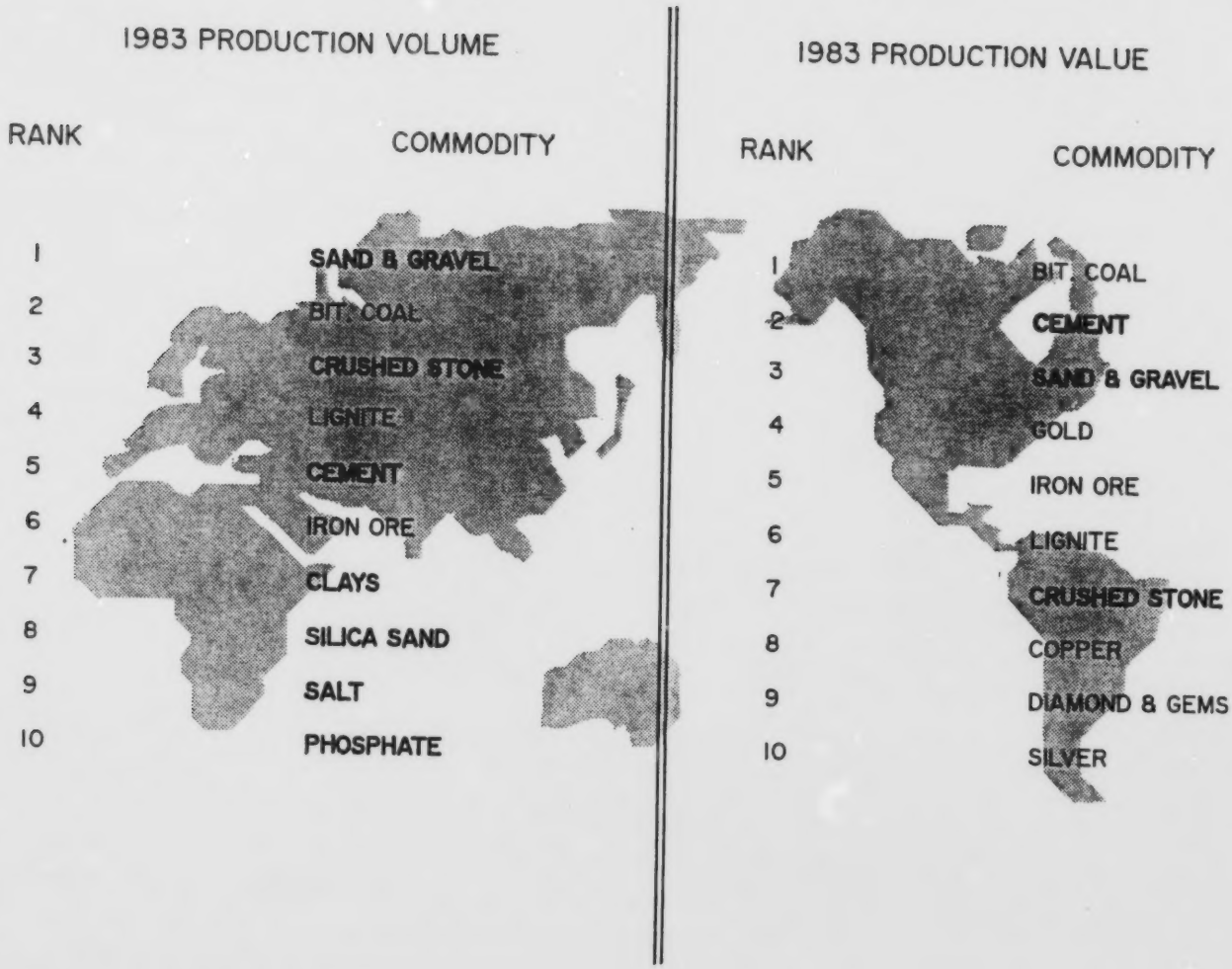
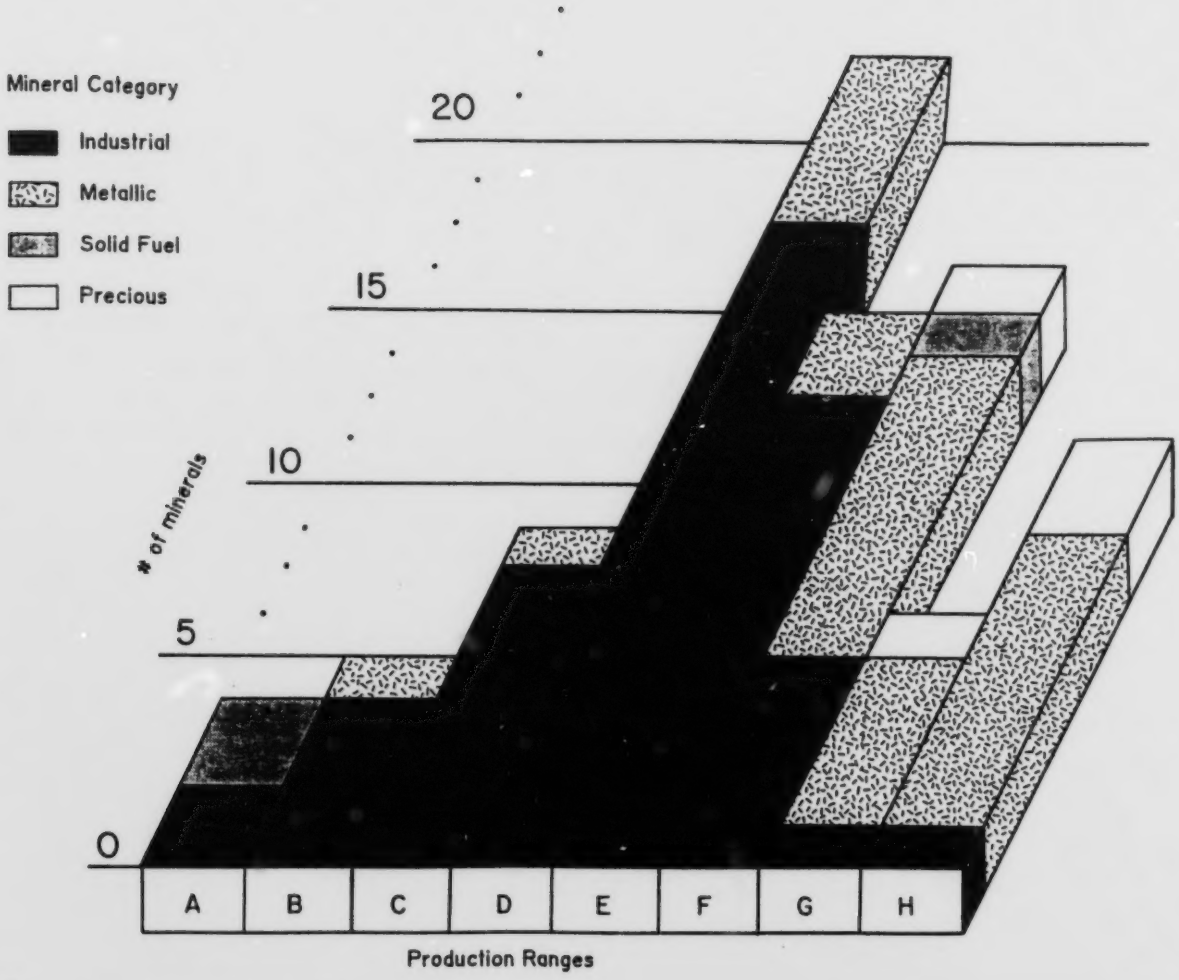


Figure 3.2 Ranking of **INDUSTRIAL MINERALS** within the top ten ranking mineral commodities relative to world production volume and value (U.S. Bureau of Mines, 1985, '86)



Range of world production
(x 1,000 tonnes)

A. > 1,000,000 B. 100,000 - 1,000,000 C. 10,000 - 100,000 D. 1,000 - 10,000
E. 100 - 1,000 F. 10 - 100 G. 1 - 10 H. > 1

Figure 3.3 Arrangement of mineral commodities by total tonnage produced in 1983 (U.S. Bureau of Mines 1985, '86)

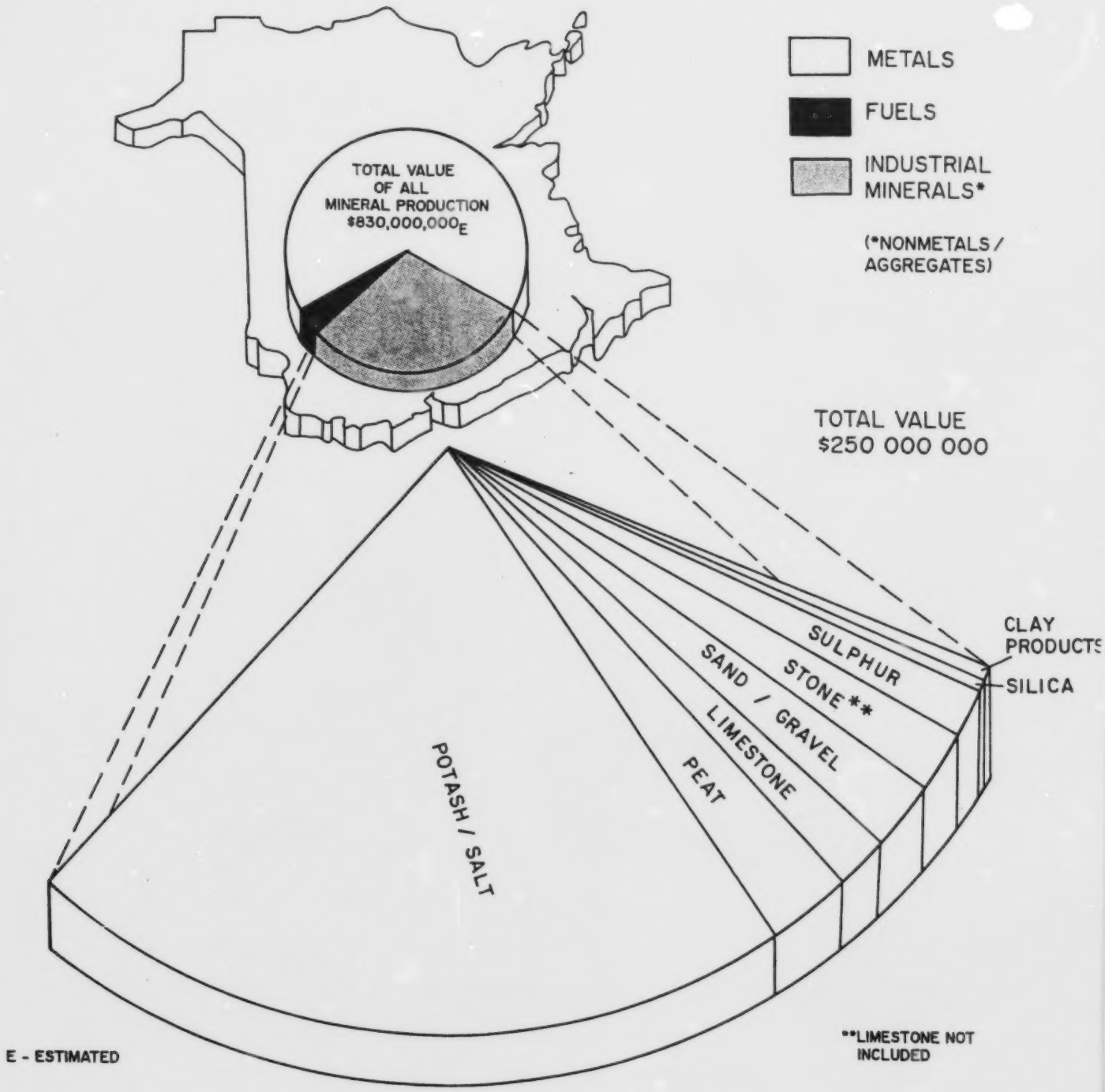


Figure 4.1 Estimated contribution of industrial minerals to New Brunswick's mineral industry in 1988 (source: Statistics Canada, 1988)

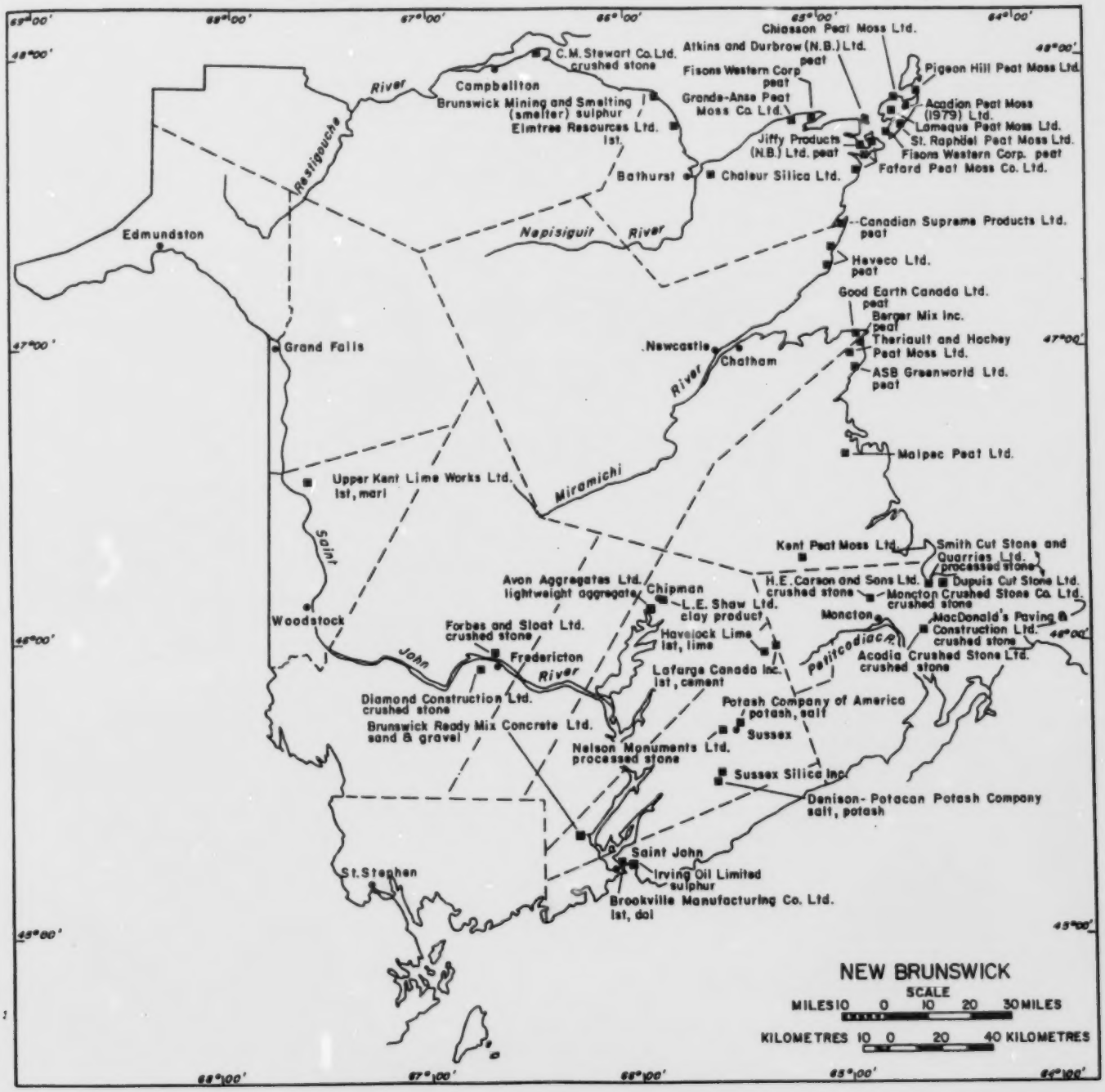
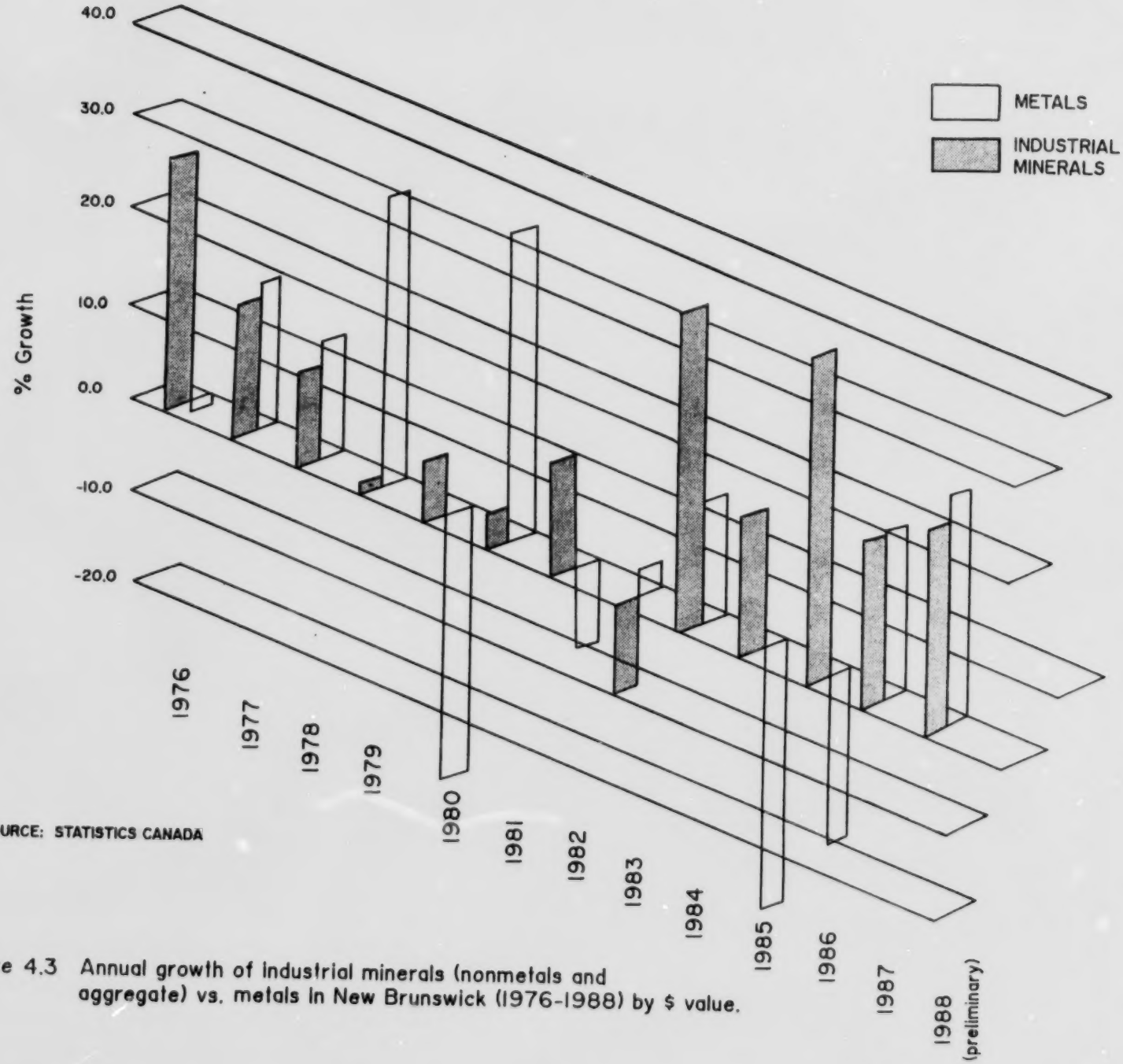

Chiasson Peat Moss Ltd.
Atkins and Durbrow (N.B.) Ltd. peat
Pigeon Hill Peat Moss Ltd.
C.M. Stewart Co. Ltd. crushed stone
Campbellton
Fisons Western Corp peat
Brunswick Mining and Smelting (smelter) sulphur
Grande-Anse Peat Moss Co. Ltd.
Acadian Peat Moss (1979) Ltd.
Elmtree Resources Ltd. lst.
Lomaqua Peat Moss Ltd.
Jiffy Products (N.B.) Ltd. peat
St. Raphael Peat Moss Ltd.
Fisons Western Corp. peat
Bathurst
Chaleur Silica Ltd.
Fafard Peat Moss Co. Ltd.
Restigouche River
Edmundston
Napisiguit River
Canadian Suprame Products Ltd. peat
Haveco Ltd. peat
Good Earth Canada Ltd. peat
Berger Mix Inc. peat
Grand Falls
Newcastle
Chatham
Theriault and Hachey Peat Moss Ltd.
ASB Greenworld Ltd. peat
Miramichi River
Malpec Peat Ltd.
Upper Kent Lime Works Ltd. lst, marl
Saint John River
Kent Peat Moss Ltd.
Smith Cut Stone and Quarries Ltd. processed stone
Avon Aggregates Ltd. lightweight aggregate
Chipman
H.E. Carson and Sons Ltd. crushed stone
Dupuis Cut Stone Ltd.
L.E. Shaw Ltd. clay product
Moncton Crushed Stone Co. Ltd. crushed stone
Moncton
Woodstock
Forbes and Sloat Ltd. crushed stone
Havelock Lime lst, lime
MacDonald's Paving & Construction Ltd. crushed stone
Petitcodiac R.
Fredericton
Acadia Crushed Stone Ltd. crushed stone
Laforge Canada Inc. lst, cement
Diamond Construction Ltd. crushed stone
Potash Company of America potash, salt
Brunswick Ready Mix Concrete Ltd. sand & gravel
Sussex
Nelson Monuments Ltd. processed stone
Sussex Silica Inc.
Denison-Potacan Potash Company salt, potash
Saint John
St. Stephen
Irving Oil Limited sulphur
Brookville Manufacturing Co. Ltd. lst, dol
NEW BRUNSWICK
SCALE
MILES 10 0 10 20 30 MILES
KILOMETRES 10 0 20 40 KILOMETRES

Figure 4.2 Industrial mineral producers in New Brunswick.



SOURCE: STATISTICS CANADA

Figure 4.3 Annual growth of industrial minerals (nonmetals and aggregate) vs. metals in New Brunswick (1976-1988) by $ value.

In New Brunswick, the unit value industrial minerals can range from $2.00 to over $90.00 a tonne. For the lower value mineral commodities, location is a critical factor to the viability of developing a deposit. Transportation can add considerable costs to delivered material. As a result lower value commodities are generally developed near urban or main consuming centers. Operators often must contend with high land costs, numerous municipal, provincial and federal government regulations and pressure from concerned citizen groups pertaining to heavy truck traffic, dust and noise and other related environmental issues.

Compared with levels of industrial mineral production in other Canadian provinces and territories, New Brunswick ranks sixth (6) in total $ value of production, third on a $ value per capita and second based on the a $ value per land area. Relative to its size, New Brunswick produces a fairly diverse assemblage industrial minerals. As indicated in figure 4.4 over eleven different industrial minerals are mined annually, putting the Province in the same category as Quebec, Saskatchewan and British Columbia. Only Ontario produces a wider variety of industrial minerals.

5.0 INDUSTRIAL MINERAL RESOURCES

5.1 AGGREGATE

Aggregate materials are very important to the economy and development of New Brunswick. Aggregates are an integral component of infrastructure development literally form the foundation of the Province's construction industry - one of it largest industries.

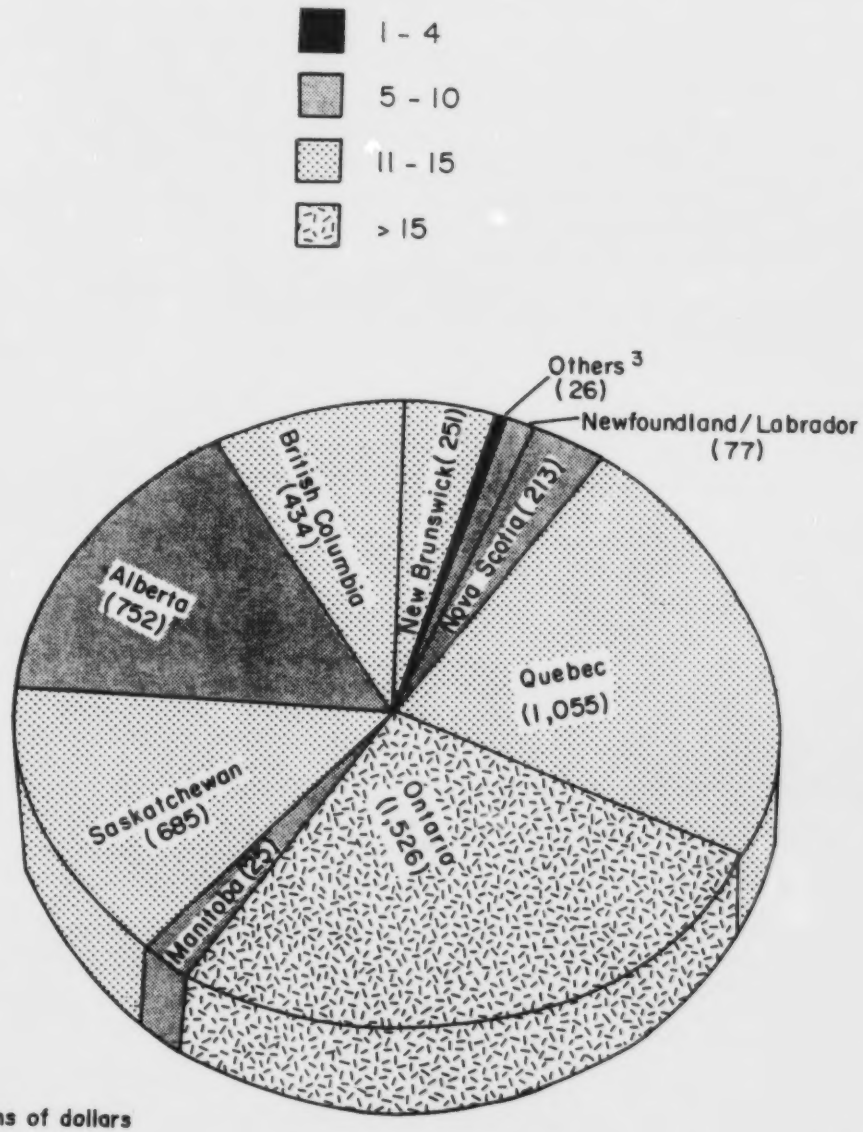
The primary use of aggregates, whether they be crushed stone or sand and gravel, is in the construction of transportation facilities. Road construction, by far the largest consumer, makes extensive use of these materials for subbase, base, fill, asphalt, concrete, chipseal, and road shoulder material. Railways use aggregates for subbase, base and ballast. Marine facilities require riprap, armour stone, and concrete for breakwater and dock construction.

Building construction, another major consumer utilize aggregate in foundations, drainage material, concrete, roofing granules, stucco, and landscaping. The concrete products industry uses aggregate in beams, pipes, and panels.

Civil engineering projects are significant consumers, as well. Water and sewer pipelines require bedding and backfill; water and wastewater treatment works use concrete, gravel, and riprap; canals and dykes need fill and riprap.

There are two major categories of aggregate materials: granular aggregate derived from surficial deposits of unconsolidated material (i.e., sand and gravel) from pits; and crushed stone derived from bedrock quarries.

Figure 4.4 1988 $ value[1] and diversity of industrial mineral[2] production by province and territory



1 Millions of dollars

2 Includes nonmetals and aggregate

3 Prince Edward Island
Yukon
Northwest Territories

Source: Statistics Canada, 1988

The aggregate industry is a major mining activity in New Brunswick. In 1988 it was estimated there were more than 60 companies producing aggregate from hundreds of pits and quarries throughout the Province. As Figure 5.1.1 illustrates, between 8.0 and 14.0 million tonnes of material have been produced in the Province every year over the last decade, accounting for total annual $ values ranging between $18 and $35 million annually.

Although granular aggregate, dominated by sand and gravel accounts for about 65 to 80 percent of the Province's total aggregate production, it contributes only 45 to 55 percent towards the total production value. Crushed stone accounts for the balance of production. Its higher value, reflects higher production costs and higher valued end uses.

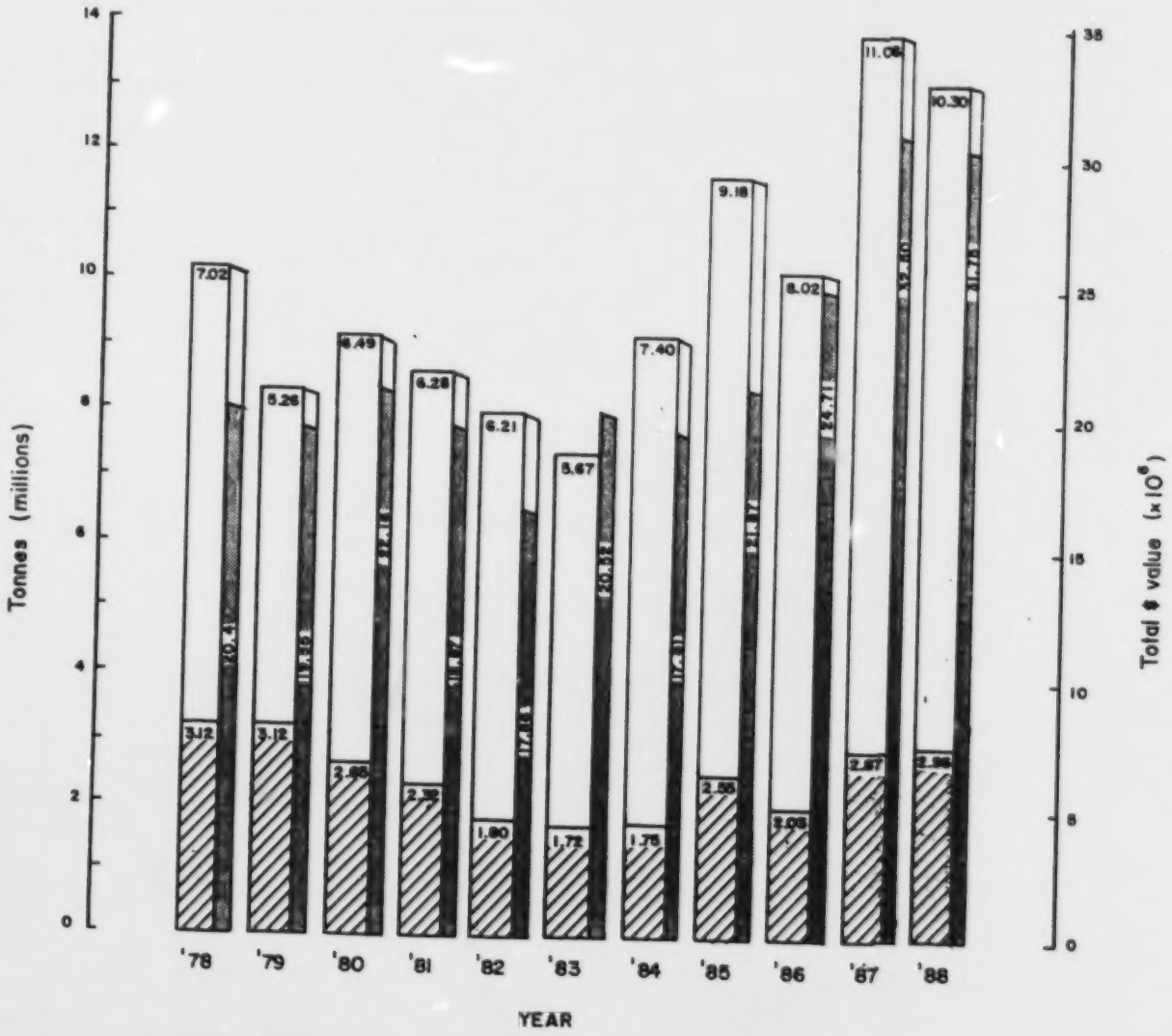
Granular aggregate has a relatively low production cost since it typically can be extracted with a front-end loader. However, the commodity has a relatively low unit value and as such is extremely sensitive to transportation costs. In regions where there are shortages of good quality granular material, it can be more economical to quarry bedrock material despite the higher costs associated with drilling, blasting and crushing. Such operations typically are located in proximity to high-demand urban areas within the Province such as the cities of Moncton and Fredericton.

The quantity and quality of aggregate resources in New Brunswick varies considerably between regions. Figure 5.1.2 relates the general distribution of aggregate resources in New Brunswick with the Province's main geologic zones. Each zone is characterized by rocks which reflect a common depositional and tectonic history.

Most sand and gravel pits in New Brunswick are operated on an intermittent, on-demand basis. Many of these can produce only low-specification material. The comparatively few more permanent operations are found where large deposits of good quality material lie within economical trucking distance of high-demand, urban areas. The pits and processing facilities of Brunswick Ready Mix Concrete Ltd., 25 km north of Saint John provide a good example of one such large operation.

Historically, there have been ten to twelve quarries producing aggregate materials from bedrock sources within the province. Three to four of these quarries produced limestone, mainly for uses other than aggregate. Several of the remaining quarries have been inoperative for many years or only operated intermittently. More recently development of additional quarries has increased so that at present at least 15 are operating although three of these are primarily limestone producers. Major operating quarries have been located in the Moncton, Saint John and Fredericton areas with smaller aggregate producers in Campbellton, Havelock and Elmtree.

Aggregate resources, directly or indirectly, form the basis of much of our economic activity, whether it be agriculture, forestry, manufacturing, or construction. Although sand and gravel have been produced and used since the days of early settlement, the economic and strategic significance attached to such materials has only recently been recognized.



Source: Statistics Canada

Figure 5.1.1 Estimated aggregate production in New Brunswick (1978-1988)

Figure 5.1.2 Generalized aggregate resource potential by geologic zone (1, Edmundston; 2, Matapedia - Aroostook; 3, Tobique - Chaleur; 4, Elmtree; 5, Miramichi; 6, Magaguadavic; 7, Caledonia; 8, Moncton Basin; 9, Central Platform)

The problems of population growth and dwindling sand and gravel resources are not perhaps as severe in New Brunswick as in some of the more populated and industrialized areas of Canada and the United States. Nevertheless, the Province is subject to similar pressures of land-use competition, decreasing reserves and material of inadequate quality. This is especially true in urban areas where heavy demands are being made. In Saint John, for example, nearly all of the readily available, high quality sand and gravel deposits are being actively developed. Although the demand for aggregate increases steadily, producers will continue to move their operations farther from the city because of competition between their operations and urban growth, and because of public complaints regarding dust, noise, traffic, and related safety concerns, associated with such extractive operations. Other urban areas in New Brunswick share similar problems.

Assuming an annual demand of about 12 000 000 tonnes, New Brunswick is expected to have sufficient reserves of sand and gravel for the foreseeable future, although there are serious shortages of high specification material in some areas of the Province. These shortages will continue to be met by transporting aggregate from deposits in other areas.

At present aggregate resources are often considered high volume, low unit value commodity, however, costs are destined to show marked increases in the years ahead.

5.2 BARITE

Barite or barium sulphate is the principal barium mineral of commercial importance in Canada. While it may be considered to have only minor significance with respect to the quantities produced, it serves a variety of important industrial purposes due to its rather unique properties. High specific gravity and softness are among its most valued properties making it an important weighting agent in drilling muds, circulated in boreholes during deep drilling operations. Drilling mud is a mixture of clay, water and various additives, specially formulated to lubricate and cool drilling bits and drill rods. It also serves as a medium carrying drill cuttings to the surface; as well as a well wall sealant employed in confining high pressure oil and gas encountered in drill holes. In 1986 drilling mud applications accounted for over 150,000 tonnes or 68% of total Canadian barite consumption, with the balance of consumption divided among several manufactured products including: paint, varnish, glass, plastic, and chemicals.

Barite is not mined in New Brunswick, however, it is found at a number of localites throughout the Province. Most of the known occurrences are of the vein-type, rarely exceeding a few centimetres in thickness. A notable occurrence near the village of Memramcook, in Westmorland County, has been periodically explored. Nearby, at Taylor Village, a zone up to 25 m wide containing both barite and celestite has been traced for a lateral distance of about 1000 metres.

5.3 BERYL

Beryl is the traditional source of the metallic element beryllium. It is a mineral commodity relatively rare and only three countries - the United States, China and the Soviet Union - produce beryllium products. Theoretically beryl contains the equivalent of 12 to 13.5 % BeO or 5% beryllium metal. However, actual ore grades mined seldom exceed a BeO content of 4 per cent.

According to the United States Bureau of Mines and Minerals, "beryllium, in a span of 60 years, has become a necessary industrial mineral." In addition its numerous important properties, beryllium serves as a useful alloying element particularly when combined with copper, nickel, aluminum and magnesium compounds.

Although not produced in New Brunswick, several beryllium occurrences are documented. Often found in association with granitic rocks, some of these occurrences are regarded as having some interesting development possibilities and may be worthy of exploration. One of the more notable occurrences is found near Zealand Station in York County, where grades up to 0.74% BeO have been reported. Other occurrences which may warrant attention are situated in west-central New Brunswick.

5.4 CEMENT

The word cement is derived from the Latin "cementum", which referred to stone chippings used in mortar. In general, the term is used to describe a wide variety of binding materials. Portland cement, patented in 1824, is the most common type of cement produced throughout the world.

It goes without saying, cement and related cement products are widely used for construction, building, and various engineering applications. As cement and concrete technology have improved over the last 50 years, the applicability and consumption of these materials have grown steadily.

In the early 1950's, the Canada Cement Company (later Canada Cement Lafarge Ltd., and now Lafarge Canada Inc.) opened a cement plant at Havelock, N.B. At that time, the operation was the only producer in Atlantic Canada. The plant was capable of producing various types of cement products, and was among the first few plants in Canada to employ what is known as a "dry process" manufacturing technology. Cement produced by this method begins with the extraction of a good quality limestone from a nearby quarry. This material is subsequently crushed and ground, and combined with varying amounts of silica, alumina, and iron oxide, depending on final product requirements. The mixture is then burned (1300-1500^{o}C) in a rotary kiln. Kiln discharge, roughly spherical in shape consists of a chemically complex mixture of calcium silicates and aluminates known as clinker. Clinker is mixed with gypsum (4 to 5 percent by weight) and ground to a fine powder to form portland cement and other special cement products. About 1.8 tonnes of raw material is required to manufacture 1.0 tonne of finished cement.

The manufacture of cement is energy intensive, requiring an average, 6 million BTU to produce a tonne of product. Approximately 75% of this energy input is accounted for by fossil fuels with and the balance represented by electrical requirements.

The Lafarge operation at Havelock, initially had an annual productive capacity of 320,000 tonnes per year. Production levels reached a peak during 1978 and 1979, but declined in the early eighties in response to a regional downturn in construction activity, high energy costs, limited export opportunities and other factors. Even though production of specialty products such as cement for offshore oil exploration programs were undertaken in an attempt to bolster sagging demand this market also soon declined. In 1983, the cement kilns at Havelock were closed but clinker grinding operations were continued using stockpiled and eventually imported clinker from another LaFarge operation in Brookfield, Nova Scotia. In 1987 the operation was discontinued and shut down indefinitely. The plant's adjacent limestone quarry continues to operate however, supplying raw limestone to an unrelated lime operation nearby. Aggregate is also supplied to a subsidiary, Permanent Concrete Ltd. The plant now serves as a distribution point for products from other company operations.

5.5 COMMON CLAY/BRICK SHALE/LIGHTWEIGHT AGGREGATE

"Common clay" is a clay or clay-like material that is sufficiently plastic to permit ready molding. It is composed of hydrous silicates--that is silica, alumina, and water--plus other minerals such as iron and alkalies. When heated to elevated temperatures the components of clay bond or fuse together forming structurally strong products of variable colour. Shale is a sedimentary rock originating from clay deposits which have been laminated under pressure.

Common clay and brick shale have been used for thousands of years in the production of a variety of structural products and are still among the most commonly used industrial mineral substances. One of the most common uses is in the manufacture of bricks and tiles (drainage tiles, roofing tiles, partition tiles). Other construction material including sewer pipe and flue linings are also produced.

The L.E. Shaw company is the Province's major producer and consumer of clay and brick shale. Although its main headquarters is in Nova Scotia, the company's association with New Brunswick dates back many decades. The Great Saint John Fire of 1877 helped solidify the business due to the surge of orders which resulted as residents of the city opted to rebuild with a nonflammable material instead of the traditional wood. The company originally established a brick plant in the Province in 1929 to utilize waste shale from various coal mining operations in the Minto-Chipman area. The plant located at Chipman now uses shale from a local quarry which was established in 1935. The shale is of a highly plastic nature and fires to a hard, dense reliable product, capable of standing the rigours of Canadian winters. In addition to brick, the Chipman plant produces flue liners, and a wide variety of tile products.

Another interesting application of shale and clay in the Province is in the production of lightweight aggregate. This material tends to reduce the weight of concrete for large structures such as bridges, high rise buildings, and large, low rise buildings with lengthy support beams. Lightweight aggregate is also used in the preparation of top course asphalt where it demonstrates a superior skid resistance as opposed to regular aggregates.

Lightweight aggregate is produced by Avon Aggregates Ltd., a division of Modern Enterprises Ltd., which operates a facility in the Minto area. A porous shale is used as the raw material. The shale is crushed and fed into a 12 metre long, coal-fired rotary kiln. At a temperature of about $650^{0}C$, thermal decomposition of the shale occurs, releasing gases including carbon dioxide and water vapour. The explusion of this gas causes a "popping" or expanding of the shale producting the lightweight aggregate material. The material is then crushed and screened to the desired size fractions for use in a variety of products. Lightweight aggregate has the potential to replace conventional aggregates in several applications. It weighs about 60 percent of an equivalent volume of conventional aggregates and demonstrates superior hardness and abrasion resistance characteristics.

The Lafarge Canada Inc. (formerly Canada Cement Lafarge Ltd.) plant at Havelock also has been a producer of shale in the Province. The shale was added to cement raw material to maintain the required calcium/silica/alumina ratio for the manufacture of portland cement. The cement operation was closed in 1987.

Since the production of clay and shale in New Brunswick has been essentially "captive" for specific uses, reliable statistics on production are generally not available. However, the value of clay and shale products produced in the Province provides an indication of the magnitude of the industry which in 1988 totalled over $2.9 million.

5.6 DIATOMITE

Diatomite is an accumulation of siliceous, skeletal remains of tiny plants called diatoms. Diatoms, one cell organisms related to algae, found in either fresh or salt water are capable of extracting silica from water and secreting it to form skeletal structures. Commercially worked deposits are the result of many thousands or millions of years of accumulation. Primary diatomite mining regions of the world are found on the west coast of the United States and in western Europe.

Diatomite is an extremely useful substance because of its chemical inertness and its unique physical properties (i.e. porosity). The chambered diatom skeleton provides unusual filtering properties, capable of removing very fine suspended material from liquids without affecting the characteristics of the liquid. Its high surface area per unit volume and low bulk density (90% voids) enhance its filter applications by reducing the required frequency of backwashing and reducing the weight of material.

The largest use for diatomite is as a filter aid in clarifying liquids. In this area, major applications include the purification of water, the clarification of beer, wine, liquor and fruit juices, the filtration of dry-cleaning liquid and the separation of various oils and chemicals. A second major end use is as a light-weight filler for paints, paper, rubber and plastics.

Diatomite occurs as soft siliceous ooze accumulated on the bottoms of several lakes in southern New Brunswick. At least twenty-seven (27) occurrences are known throughout the Province. Most have been tested for quantity and quality at one time or another. It appears that some of the better deposits occur in three lakes near St. George, in Charlotte County, where total estimated reserves collectively amount to more than 100 000 tonnes (calcined).

Limited amounts of diatomite were once produced in the Sussex area during the early 1950s (near, Mechanic Lake). Active exploration and development of the Province's diatomite resources is not currently being pursued.

5.7 DIMENSION STONE

The term dimension stone traditionally has included building stone, monumental stone, ornamental or decorative stone, paving blocks, curbstone, slate, and flagstone; and a variety of specialized uses such as grindstones and curling stones. More recently however, various products including stone slabs and panels for building cladding and sidewalks and stone applied to landscaping and streetscaping have also become synomomous with the term. The word "dimension" is used in a context implying that a stone has undergone some form of shaping or finishing process. This shaping, finishing or fabrication phase can involve sawing, grinding, honing, polishing, carving, turning, chiselling, thermal treatment, and related techniques. In some cases certain dimension stone products are produced with a rough or split face. The fabrication or finishing plant is often separate from the quarry operation and may use stone from several quarries including out-of-province and imported sources.

The structural integrity and aesthetic appeal of natural stone are only two of several properties which make it a desirable building material.

The use of stone in New Brunswick dates back to its earliest settlers. Buildings constructed from stone was a traditional practice, despite the abundance of lumber. Stone was frequently selected as a reliable construction material particularly for "public" buildings such as churches, post offices and similar structures.

There are several categories of dimension stone. Although several rock types are used, limestone, marble, granite, and sandstone are among the most common. Sandstone and granite are the principal types which have historically been produced in New Brunswick, whereas materials such as limestone and marble have for the most part been imported. This production preference reflects not

only the geology of the Province but also reflects on the local availability of suitable stone resources. A classic 1914 report by W. A. Parks describes in considerable detail the characteristics of stone from numerous quarries that once operated throughout the Province. The report makes mention many local examples depicting the use of a particular type of stone.

An accurate historical account of the stone industry in the Province appears at first glance to be hampered by limited documentation which is readily accessible. The sandstone side of the industry is assumed to have developed earliest. Sandstone quarries were concentrated mainly in the eastern half of the Province. One common feature of these early enterprises was that most were located on or near the coast from where stone was frequently shipped by sea to various export destinations. In addition to the numerous buildings in the Maritimes constructed from domestic sandstone resources, New Brunswick stone has been used in buildings and structures in Montreal, Hamilton, Ottawa, Toronto, Boston and New York.

Granite quarries have also been concentrated in certain regions of the Province, reflecting the nature of the bedrock geology. The Charlotte County region has traditionally been regarded as the center of the granite industry in the Province (and in the Maritimes) Quarrying began in the St. George area in 1872. In 1911 as many as , five firms operated processing facilities in St. George, finishing both "local" stone and material brought from the Bocabec and Spoon Island areas and some imported stone. The St. George operations tended to extract stone solely for their own finishing plants and sales of "rough" stone were often infrequent. Import duties on finished stone for the United States market, higher freight rates to Central Canada for finished stone relative to rough stone, and competition from imported stone finished at other locations around the world were among the factors which limited and eventually smothered the industry. In 1932 only four companies were operating in the region. Over four dozen quarries have been opened, however many were small and were abandoned when unfavourable rock characteristics were encountered. The distinctive red granite of the St. George area is perhaps the best known product of the region, however, black, grey and pink colored stone has also been produced from time to time.

In the vicinity of Saint John, granite quarries near Spoon Island are among the best known in the Province. Both a pink and greyish blue granite have been produced. In the Bathurst region the light pink Antinouri Lake granite and a grey granite near Pabineau have been used in numerous buildings at several locations in Bathurst. In the Fredericton-Woodstock region there apparently was at one time a operating quarry at Pokiok. Large granite boulders have been collected in the MacAdam area and finished into building stones.

The Province's stone industry has traditionally been closely related to the construction industry, although some stone has been used for monumental purposes from time to time. Early construction practices reveal that exterior building walls were load bearing and stone was often used as a reliable base course to support the entire weight of the structure. However, increased use of structural steel and reinforced concrete led to a decline in the requirement of

stone after the First World War. In cities the appearance of the upper storeys of large buildings was not important because grime often covered the exterior. A stone veneer or face brick could be used to cover the lower 1 to 2 storeys to improve the appearance for passerby but the remainder was not visible and there was little incentive to use attractive cladding materials. In brick buildings, base courses, steps, window sills and lintels, and corner blocks were often made of stone for appearance purposes but overall use gradually declined. Eventually high costs associated with the quarrying and finishing stone compared to cheaper materials more readily available were probably among the factors contributing to its demise as a primary construction material.

The period prior to 1920 probably was the most active for the industry in the Province. Production in 1921 was 14 000 tons, declining to 9000 tons by 1925. Between 1925 and 1950 production sank below 6000 tons (except two years 1930, 46 000 tons, and 1935, 31 000 tons) and dropped to only 60 tons by 1946. Recent statistics on quarry output in the Province are unreliable since output eventually has become associated with crushed stone production from bedrock aggregate quarries.

With the decline in stone use related to changes in general construction practices, the market for stone products became almost exclusively centered around memorial stone after 1946. Although some curbstone and bridge construction material were produced from time to time concrete was often the favoured material. More recently architectural trends and tastes have changed and there has been a resurgence in the use of stone and the stone industry in North America. New production techniques permit thin (1 1/2 inch) stone panels to be produced. New fastening techniques and prefabrication approaches have reduced installation costs. Up until recently almost all of the stone products used in North America were imported but North American finishing plants, particularly in Quebec, have now been equipped to effectively complete required finishing and more domestic stone is now being utilized. Quarrying techniques have also progressed. New blasting techniques and flame cutting technology have improved the extaction of stone from quarries. Provision of stone for restoration purposes, particularly sandstone, also appears to be a growing trend that will ultimately require additional production and skilled labour.

The use of granite as curbing in bridges has been practised extensively in New Brunswick for the past decade. Resistance to salt and to physical damage from snow removal equipment are among the principal factors involved. The use of granite curbing for city streets is also increasing. Life cycle costing indicates that while the initial installation costs are slightly higher than concrete curbing, long term maintenance costs are lower. Thus the use of granite curbing can now be based on economic rather than aesthetic criteria.

At present, there are two companies in the Province who operate quarries. These companies, and two additional firms, have various levels of stone fabrication and finishing capabilities. Smith Cut Stone and Quarries Limited, in Westmorland County, have produced an olive-green sandstone at its Shediac location since the early 1800's. A red sandstone quarry has been recently operated in the Sackville area. These quarries have operated on a demand basis in recent years.

The Smith fabrication plant is equipped with a gang saws, diamond saws, planers, polishers and a variety of associated equipment. Stone for numerous buildings both in and outside New Brunswick have been processed by this firm over the years. The New Brunswick Museum in Saint John, the Cathedral in Moncton, and various buildings on the campus of Mount Allison University in Sackville, are but a few prominant examples.

Nelson Monuments Ltd., headquartered in Sussex Kings County, is the largest company of its kind in the Maritimes. The company formed in 1909 has remained in the control of various family members since that time. The firm initially was located in the Hopewell Cape area of Albert County but erected new facilities in Sussex in 1959. Although the company had its early beginnings producing sandstone it now tends to concentrate on granite. The firm presently owns several granite quarries throughout southern New Brunswick including Spoon Island, Dawson Mountain, and Digdeguash Lake and operate them on a demand basis. The Spoon Island quarry is the most active.

Nelson's principal product are stone memorials. A large percentage of monuments produced however, use imported stone. Bases for memorial stones, curbing stone, and a variety of other custom made products are also manufactured using domestic stone. The company's plant is equipped with a 3.5 m diameter diamond saw, several smaller diamond saws, polishers, drills and corers, flame treatment equipment, blasting and lettering facilties, and related equipment.

Smet Monuments of St. Stephen, Charlotte County produces granite monuments, bases and markers using mainly imported stone. The plant is equipped with polishing and finishing equipment and lettering facilities.

Dupuis Cut Stone Ltd. operates an ornamental stone manufacturing facility near Shediac, Westmorland County. They have produced sandstone products for building construction (Moncton High School addition and the Parliament Buildings, Ottawa) and are capable of producing various stone products for ornamental and landscape purposes.

5.8 FLUORSPAR

Fluorspar is the commerical name for the mineral fluorite. Chemically known as calcium fluoride, it has the formula CaF_2 and in its purest form usually contains 51.1 percent calcium and 48.9 percent fluorine.

Fluorspar is produced in three principal grades--acid, ceramic and metallurgical, each reflecting its main area of consumption.

Acid-grade fluorspar or acidspar, generally contains a minimum of 97 percent calcium fluoride and is generally used as a feedstock in the manufacture of hyrdofluoric acid. Both the chemical and aluminum industries account for a large percentage consumption. Fluorocarbons produced by reacting hydrofluoric acid with carbon tetrachloride or chloroform, are used in the manufacture of

solvents, resins, plastics, films, refrigerants and aerosol propoellants. The increasing concern over the effect of fluorocarbons on the earth's atmospheric ozone layer, will undoubtly have an impact on the future consumption of fluorspar in this particular end product.

The ceramic industry uses fluorspar in the production of various glasses and enamels. Other applications are as an abrasive on certain types of sandpapers.

Metallurgical grade fluorspar or "metspar", is used primarily by the iron and steel industry. The importance of metallurgical-grade fluorspar in the steel industry focuses on its ability to remove impurities (sulphur and phosphorus) and to improve the separation of metal and slag during the melting process.

There is currently no production of fluorspar in New Brunswick, however, indications of fluorite mineralization are found at over 35 locations.

5.9 GLAUBERITE

Glauberite, an anhydrous sodium-calcium sulphate ($Na_2SO_4.CaSO_4$), can be considered as a potential source of sodium sulphate (Na_2SO_4) more commonly referred to "salt cake". A bulk of world salt cake production is consumed in the manufacture of kraft or brown paper, detergents and glass. For these products regular grade material with a minimum Na_2SO_4 content of 97 per cent is usually required. Since pure glauberite contains a maximum of only 51.1 per cent Na_2SO_4, New Brunswick deposits would require significant upgrading to meet grade specifications.

There are two reported occurrences of glauberite in the Province, - one near Weldon-Gautreau in Albert County and the other at Cornhill East in Kings County. In both areas, the mineral is found initimately associated with rock salt, anhydrite, and shale at depths 425-940 m below surface. Exploratory drilling in the Weldon-Gautreau area during the early 1960s has revealed that rock salt and associated glauberite mineralization, is restricted to a small structural, sedimentary basin. The salt body contained in this basin is reported to form an elliptical-concave lens with an areal extent of about 1300 ha. In situ reserves may exceed several million tonnes with an average grade of 23% Na_2SO_4. There is a possiblity that additional reserves could be outlined, however, more exploration is required to verify the extent of the resource.

A drill hole in the Cornhill East area has also intersected rock salt and minor glauberite mineralization with an average grade of 10% Na_2SO_4. There are few indications of its extent.

5.10 GRAPHITE

Graphite, like coal and diamond, is a naturally occurring form of carbon. It is a soft, unctuous, lustrous, black mineral. Its rather unique assemblage of properties, gives it a wide range of industrial applications.

Almost 80% of graphite annually consumed in Canada and over 50% consumed in the United States finds it way into metallurgical industry. One of graphite's largest single use, is as a foundry facing, where finely pulverized graphite is applied as a surface coating to casting molds, permitting the easy removal of metal castings after cooling.

A second-ranking end use of graphite is in the steelmaking process itself, where large quantities of graphite are used to recarburize steel. A third metallurigical application is in the production of refractories and crucibles for melting nonferrous metals.

Significant quantities of graphite are utilized as lubricants. A thin veneer of graphite on moving parts greatly reduces the coefficient of friction, while providing improved resistance too corrosion at the same time. Other applications are found in the manufacture of "lead" pencils, batteries, carbon brushes in electric motors, electrodes, brake linings, protective paint for steel structures and a host of other commodities.

Graphite products are generally classified by particle size - crystalline or flake grade material contains crystals large enough to be distinguished with the unaided eye whereas amorphous material is of a finer texture. Crystalline flake graphite is the most valuable form of the mineral.

Natural graphite is mined at only one location North America, situated in Canada, in the Province of Quebec. However, there are a number of graphite deposits currently being evaluated in Ontario and Quebec which will be brought into production in the near future.

Although graphite is not currently mined in New Brunswick, several notable occurrences largely restricted to the City of Saint John area, have been documented. Deposits generally consist of highly sheared carbonaceous material within limestone and related sedimentary rocks of Precambrian age. Some of these have been actively explored in recent years.

One of the better known occurrences is at Golden Grove, approximately 25 km northeast of the City. Discovered more than 50 years ago, this occurrence has been the subject of numerous cursory investigations. Recently, interest in the property has been renewed resulting in more detailed geologic and geophysical studies further defining the deposit's extent and quality. Trenching has indicated a graphite horizon 2 m in width with a 425 m strike length, containing zones of relatively high grade carbon. Possible reserves, based on the continuity of the material projected to depths of 150-300 m, are estimated to be 225 000 to 450 000 t; however, the extent and grade of the deposit at depth has yet to be confirmed.

Preliminary mineralogical and metallurgical test work appears to indicate some potential for the Golden Grove deposit as a source of flake graphite.

5.11 GYPSUM

Gypsum is a hydrous calcium sulphate with the chemical formula, $CaSO_4.2H_2O$. When calcined or heated to temperatures between 120° and 205°C, gypsum loses three-quarters of its water of hydration. Its new chemical formula becomes $CaSO_4.1/2H_2O$. Calcined gypsum or hemihydrate of calcium sulphate is commonly known as "plaster of paris". When gypsum completely loses all its water of hydration at temperatures exceeding 700°C, it becomes an anhydrous calcium sulphate, commonly referred to as anhydrite ($CaSO_4$).

Gypsum deposits are documented at some 27 locations throughout New Brunswick. Deposits fall into four main categories depending on their differing textural characteristics. They can be massive, laminated, nodule-bearing or disseminated. The last two types are the least important economically because of impurities, which include variable amounts of carbonate, silica, and argillaceous materials.

The massive and laminated gypsum deposits located 20 km south of Moncton, near Hillsborough are probably the most significant in the Province. Here, gypsum occurs in two small fault-bounded sedimentary basins. The beds are gently dipping and thicknesses up to 20 m have been reported.

While gypsum has many applications, most gypsum production is directed to four main uses: prefabricated products (wallboard), plaster, portland cement, and agriculture. Together, these uses accounted for over 99 percent of consumption in the United Sates and Canada in recent years. In Canada approximately 70 percent of gypsum production is exported annually, almost entirely to the United States. Of the material used in Canada the largest proportion is for wallboard.

Gypsum has played a small but significant role in the mineral economy of New Brunswick for over a century. In the early 1800s farmers quarried it to use as a soil conditioner known as "land plaster". Up to the early 1980's, there had been almost continuous production of gypsum in the Hillsborough area of Albert County since the 1840's. Other deposits at Intervale, Sussex, Upham and Plaster Rock have also been past producers.

Exports of raw gypsum from Hillsborough in the 1840's were shipped by coastal vessel to "plaster" mills in Lubec, Maine and other United States destinations in the 1840's. In 1854 the Hillsborough operations were sold to the Albert Manufacturing Company. Production facilities were enlarged and a calcining mill was constructed. Shipments of manufactured product to the United States, continued until the withdrawal of reciprocal trade relations between Canada and the United States prior to the 1980's.

The high quality of the Hillsborough material however allowed retention of some of the U.S. market share. In 1876, the Intercolonial Railway (now the Canadian National Railway) was constructed making it possible to supply a share

of the central Canadian market. However, operations near Montreal and in Ontario, as well as the United States provided stiff competition. The institution of a Canadian protective tariff combined with the superior quality of the Hillsborough material eventually led to the a major share of the Canadian market. In 1877 total sales in Canada were 8000 barrels; by 1897 Hillsborough was selling about 38 000 barrels on the Canadian market. In the same time period shipments of crude gypsum to the United States continued, increasing from 5000 tons to 59 000 tons. The imposition of import duties on crude gypsum products led to a gradual decline in this market. Total loss of the market to western U.S. producers was prevented due to the lobbying efforts of the eastern U.S. manufacturer's and pressure exerted by the owners of coastal vessels who transported coal from New York north to New England ports and used the gypsum as a "backhaul" commodity for the return trip.

The Hillsborough plaster mill was destroyed by fire in 1911. It was rebuilt and enlarged to a capacity of 1000 barrels of plaster per day in 1912. Just prior to 1930, two large reinforced concrete silos equipped with ship loading conveyors were constructed at a docksite on the Petitcodiac River nearby. These silos, which are still standing, are believed to be the first concrete structures erected in eastern Canada using the continuously poured slip ring method of construction.

In 1930, the first wallboard plant in eastern Canada was constructed at the Hillsborough manufacturing facility by the Canadian Gypsum Company who had just acquired the plant. The calcining capacity of plant was increased. Shipments of crude gypsum ceased shortly after the end of the Second World War.

Underground mines were common in the Hillsborough area up until 1958. A room and pillar extraction method was generally used with some "rooms" reaching 14 m in height. Surface quarries were also developed and eventually became the only extraction method employed.

Peak production of gypsum from Hillsborough was reported in 1906 at a rate of about 119 000 tonnes per year. Production rates of 75 000 to 100 000 tonnes per year were common in the 1950s and 1960s. About 40 000 to 50 000 tonnes per year were produced during the 1970s. This production was used for the captive manufacture of gypsum wallboard by the Canadian Gypsum Company. Gypsum production ceased with the closure of this facility in 1980 - a situation brought on by a significant downturn in wallboard sales to the construction industry, high transportation costs, and antiquated equipment at the plant.

A gypsum deposit at Intervale about 5 km north of Petitcodiac in Kings County, has also operated periodically since 1880. The Albert Manufacturing Company produced about 1300 tons per year from 1932 to 1935. In 1950, the property was acquired by Canada Cement Company Limited (now Lafarge Canada Inc.) who have quarried gypsum on an as required basis for use as a retarding agent in the manufacture portland cement at a nearby cement plant at Havelock.

Deposits in the Tobique Valley area (Figure 6.11.4) of Victoria County in northwestern New Brunswick, regarded as poor quality material for plaster were in high demand as a soil amendment ("land plaster") in the 1890s. One of the reasons for construction of a railway from Perth to Plaster Rock was infact for transport of this material. The Tobique Valley Gypsum Mining and Manufacturing Company was incorporated in 1893, erecting crushing and grinding equipment near the rail line. Although some production was achieved with good results reported for use as "land plaster", difficulties were encountered with railway rates and facilities. Despite an ownership change in 1897 no further significant production has taken place since.

Since 1986, the Eastern Gypsum Company is persuing the establishment of a wallboard manufacturing facility at MacAdam in York County, to serve northeastern U.S. markets. They have evaluated gypsum deposits in the Albert County area and near Sussex as potential sources of supply. This proposed development is the most topical subject with regard to the future of gypsum production in the Province.

A form of by-product gypsum is also produced in the Province. This material is a chemical by-product of manufacturing processes resulting in the production of phosphoric acid. Brunswick Mining and Smelting Corporation Limited (Fertilizer Division) produces substantial quantities of phosphogypsum as a waste product of fertilizer production.

The sludge produced by scrubbers during flue gas desulphurization in coal fired thermal power plants could eventually become potential sources of gypsiferous material in the Province.

5.12 KAOLIN

Kaolin is a white clay consisting principally of the mineral kaolinite, a hydrous aluminum silicate ($Al_4Si_4O_{10}(OH)_8$) generally formed as an alteration product of weathered igneous rocks.

Kaolin has several important properties which make it a very useful industrial mineral. Its primary use is as a coating pigment and mineral filler for various types of papers. Good quality kaolin is invaluable in guaranteeing a smooth paper surface, - a paper surface which is even and uniformly absorbent for printing. While proportions may vary, some papers contain up to 35 per cent (by weight) of kaolinitic clay as a coater and filler. It is also used as a filler in paint, plastic and rubber and in the manufacture of ceramic ware of all kinds.

Kaolin clays have never been commercially produced in the Province. However, the material is a notable component of a silica deposit currently being developed near Sussex by Sussex Silica Inc. Screening and washing operations associated with silica benefication separates the very fine particle fractions routing them to a settling pond. Although a significant component of this reject material is kaolin, fine silica and other deleterious materials are also present. A method of separating this material from the kaolin would have to be evaluated. As well, product quality and market interest are important factors in assessment of the production potential at this particular location.

5.13 LIMESTONE/DOLOMITE/MARL/LIME

Limestone and its chief derivitive, lime, are among the most versatile mineral commodities produced today. It is absolutely vital to our 20th century lifestyle, forming the backbone of the modern construction, chemical and manufacturing industries. Virtually every manufactured product has required limestone or lime during at least some phase of its manufacture, either directly or indirectly.

The strategic importance of limestone is often overlooked or erroneously minimized in favour of other high profiling, more costly and scarcer mineral commodities that are essential for a few important uses, but not for industry as a whole. In New Brunswick, limestone not only serves as a critical raw material to many industries, but its prominence both in terms of the direct and indirect employment it generates and the dollar value it contributes annually to the Provincial economy is quite significant.

Limestone, one of earth's most plentiful mineral commodities is commercially mined and quarried in all but one state of the United States and six provinces of Canada.

Limestone is a sedimentary rock composed primarily of the mineral calcite ($CaCO_3$). Dolomite, (or dolostone) is also a sedimentary rock composed primarily of the mineral dolomite ($CaMg(CO_3)_2$). Several other components can also be present is these rocks but generally are regarded as impurities that detract from the quality of a deposit. The term "carbonate" or "carbonate rock" is often used in a general sense to identify these rocks. The term "limestone" is frequently used in a generic context to describe the material without regard to strict limits of chemical composition.

Marl is an unconsolidated material with a substantial carbonate content often deposited in shallow lakes. It is included in the generic limestone category.

Lime does not occur in nature. It is manufactured by calcining (burning) stone with a high calcium carbonate content. The primary raw material for lime however, is in fact limestone. At the calcine temperature of 900°C, CO_2 dissociates from $CaCO_3$ leaving CaO (quicklime). When quicklime is mixed with water it forms a hydrate (hydrated calcium oxide), $CaOH_2$.

Agricultural lime is actually a finely crushed limestone that is not calcined. While this commodity is commonly referred to as "lime", the usage of the term is incorrect.

Even though the use of lime and limestone probably dates back to prehistoric times, the ancient pyramids of Egypt provide the earliest evidence of its varied construction applications, being utilized as both a dimension stone and a bonding agent.

Limestone has four important properties which make it a very versitile mineral commodity. It's hardness and durability make it a useful source for building and highway aggregates. It's alkalinity makes it a popular "sweetener" for sour soils and sour gases. At high concentrations of calcium, limestone becomes an excellent raw material for the manufacture of quicklime and hydrated lime. Limestone is a key material in the formation of cement and plaster.

Because of its comparitively low cost, lime is one of the most widely and heavily used industrial chemicals (along with sulphuric acid). Lime's (quicklime and hydrated lime) alkalinity is effective in neutralizing acids in various industrial processes. Quicklime readily absorbs water from the atmosphere making it a most useful dessicant. Both hydrated lime and quicklime react with carbon dioxide to form insoluble calcium carbonate effectively removing both carbon dioxide and lime from solution. The affinity of lime for silica benefits both the smelting process and the glass industry.

The occurrence of limestone in New Brunswick has been known for over 350 years. In the 17th century, Champlain, one of the first explorers to the New World, described it from exposures visible in the vicinity of what is now the City of Saint John. In fact, these particular limestones were probably among the first rocks mined in the Province.

As the early settlers established themselves throughout the Province, numerous small lime kilns were active in just about every settled region. These pioneers appreciated the agricultural and construction attributes of limestone and made good use of the resource to supply their own local needs. Early lime kilns, the remains of which are still visible at a few locations throughout the Province, generally consisted of small, wood-fired, shaft-type structures rarely more than 3 m high, seldom covering an area exceeding 3 square metres. Generally constructed of heat-resistant field stone, they were often located on steep hillsides, allowing easier charging. These primitive operations were gradually supplanted by larger kilns as the limestone industry in the Saint John area developed into a thriving business in the mid-1800's. By 1890, as many as 25 lime-burning units were in operation in the area carrying on a thriving local, as well as export trade with the United States.

By the 1930's, the New Brunswick limestone industry had developed most of its present day characteristics, consisting of eight active quarries, four operating lime kilns and one operation producing hydrated lime. Although Saint John still remained the Mecca of the industry, small producers also became established in the northern and eastern parts of the Province, near Bathurst and Moncton, respectively.

In 1952 a major player was added to the list of New Brunswick limestone producers/consumers, when the Canada Cement Company Limited began cement production at Havelock in Kings County, the first cement plant in the Martimes.

As demonstrated earlier the uses of limestone and lime are highly diversified. For over 30 years this mineral commodity has been an important part of New Brunswick's construction, mining and smelting, pulp and paper, and agriculture industries. The New Brunswick, limestone industry consists of five producers: the Brookville Manufacturing Company near Saint John, Havelock Lime and Lafarge Canada Inc. west of Moncton, Elmtree Resources Ltd. north of Bathurst, and Upper Kent Lime Works Ltd. north of Woodstock. Together, these operations account for limestone production between 680,000 to 700,000 tonnes per year, contributing several million dollars annually to the provincial economy. In value of production, limestone ranks as the Province's sixth most important mineral commodity, however, because of its low unit cost, it only contributes approximately 2 to 3 percent of the total value of all mineral production. This apparent low cash contribution is a bit misleading and is really not a true indicator of limestone's true importance. A host of limestone based products are manufactured in the Province including: chemical process stone (for pulp mills, glass plants, smelter flux), pulverized stone (aglime, asphalt filler, dusting coal mines), crushed stone, quick and hydrated lime, and other miscellaneous products.

Limestone is represented to some extent in virtually every geologic system in New Brunswick, however, it is only in the Carboniferous, Silurian (Ordovician), and Precambrian Systems that it attains sufficient extent, thickness, and grade to be considered a deposit of some significance. In addition to these "hard rock" deposits, marls believed to be several thousand years (Quarternary age) old are also found scattered throughout the western and northwestern parts of the Province.

Even though overall limestone reserves within the Province appear adequate to meet future regional demands for most limestone products currently manufactured, it is becoming increasingly important to identify potential resources for those more quality dependant and highly specialized uses of the future (flue gas desulphurization, waste management etc.).

This is particularly important in light of the increasing trend toward more stringent raw material specifications by consuming industries and increased land use pressures from expanding urban communities. Although limestone reserves in the Province would at first glance seem immmense, their true value as a resource depends not only upon their special chemical and physical properties for specific needs, but also on the quantities of material available, its proximity to potential market areas and restrictions placed on resource development.

5.14 MANGANESE

Manganese is a hard brittle, greyish-white metal, therefore its inclusion as an industrial mineral requires some explanation. Around 90 percent of all manganese produced in the world is consumed by the iron and steel industry where it is considered essential as a deoxidant and desulphurant in the production of crude steel. The balance of consumption is represented by nonmetallurgical applications and that is where its affiliation with industrial minerals is rooted.

Manganese, common to a wide range of crystalline rocks, is ranked as the twelfth most abundant element in the earth's crust. Manganese ores may occur as oxides, carbonates or silicates, however, the most important natural sources are found in oxides usually in the form of manganese dioxide. The most important manganese dioxide mineral is pyrolusite.

Nonmetallurgical applications of manganese form the most diversified part of total world consumption. Manganese is used in feed, fertilizer, food, fragrances, fungicide, bricks and tiles, glass manufacture, welding fluxes, water purification, to mention but a few. Probably the largest and most common single nonmetallurgical use of manganese dioxide is as an oxidizing agent in the production of dry-cell batteries.

There are almost 60 manganese occurrences reported in New Brunswick. Of these, it would appear that deposits associated with Ordovician-Silurian slates in the Woodstock area would have the most favourable development potential. These deposits probably represent the largest reserves of manganese in North America. Needless to say, successful production of manganese from these deposits alone, could probably supply the entire North American market. The major restraint to development however, lies in the field of process technology. The very fine-grained texture of these manganese-bearing slates and the intimate association between iron and manganese in the ore presents a difficult separation problem. Ore treatment techniques considered to date are not considered sufficiently cost effective to yield a variety of competitive products.

Of those deposits investigated in the Woodstock area, those at Plymouth, North Hartford and South Hartford are probably among the most promising from a tonnage and grade consistency viewpoint. These deposits and others in the area (Iron Ore Hill, Moody Hill and Sharpe Farm) were once subjected to a fairly extensive exploration effort by Stratmat Ltd. in the 1950s. Several other smaller reconnaissance exploration programs, by various companies, were also undertaken in the 1960s and 1970. As a result, a plethora of useful information is available concerning various geological aspects and processing technologies associated with these deposits.

Although higher grade manganese deposits have been discovered in limestones, in bogs and in shear and fracture zones throughout the Province, it has been historically proven that most of these, with few exceptions, represent only local concentrations, lacking grade continuity, and are therefore not amenable to large scale mining practices. Some of the occurrences were at one time worked profitably around the latter part of the nineteenth century. In those days, the worlds steel industry was just emerging as a major consumer of high grade manganese. Small, local operations in the Province were able to keep pace with demand and low labour costs allowed for "high grading" of lower grade deposits. Early operations such as those at Tetagouche Falls, Woodstock, Jordan Mountain, Markhamville, Gowland Mountain, Turtle Creek, Quaco Head, Shepody Mountain and Dawson Settlement all played significant roles in the early development of provincial manganiferous deposits.

The two world wars provided additional stimuli for interest in New Brunswick manganese. The importance of an uninterrupted supply of this particular raw material for the steel industry during wartime resulted in managanese being declared a "strategic" metal. This subsequently led to further attempts to develop known deposits.

After World War II, the strategic importance of manganese was carried over into the 1950s. Increased exploration activity associated with the significant discovery of the Bathurst-Newcastle base metal deposits probably provided some additional incentive for continued manganese-related exploration, however, manganese exploration in the 1950s took on a different approach than earlier efforts. The fast expanding steel industry was requiring larger tonnages of high grade material. As a result, the small and erratic, high grade deposits in the province were more or less forgotten. Instead attention was directed to the lower grade, high tonnage manganese deposits near Woodstock and toward the development of processing technologies to beneficiate these low grade ores. Eventhough it was demonstrated that Woodstock manganese ore could be upgraded, the costs of processing compared with the price of cheaper imported material forced the eventual abandonment of significant manganese-related exploration in the area by the early 1960s.

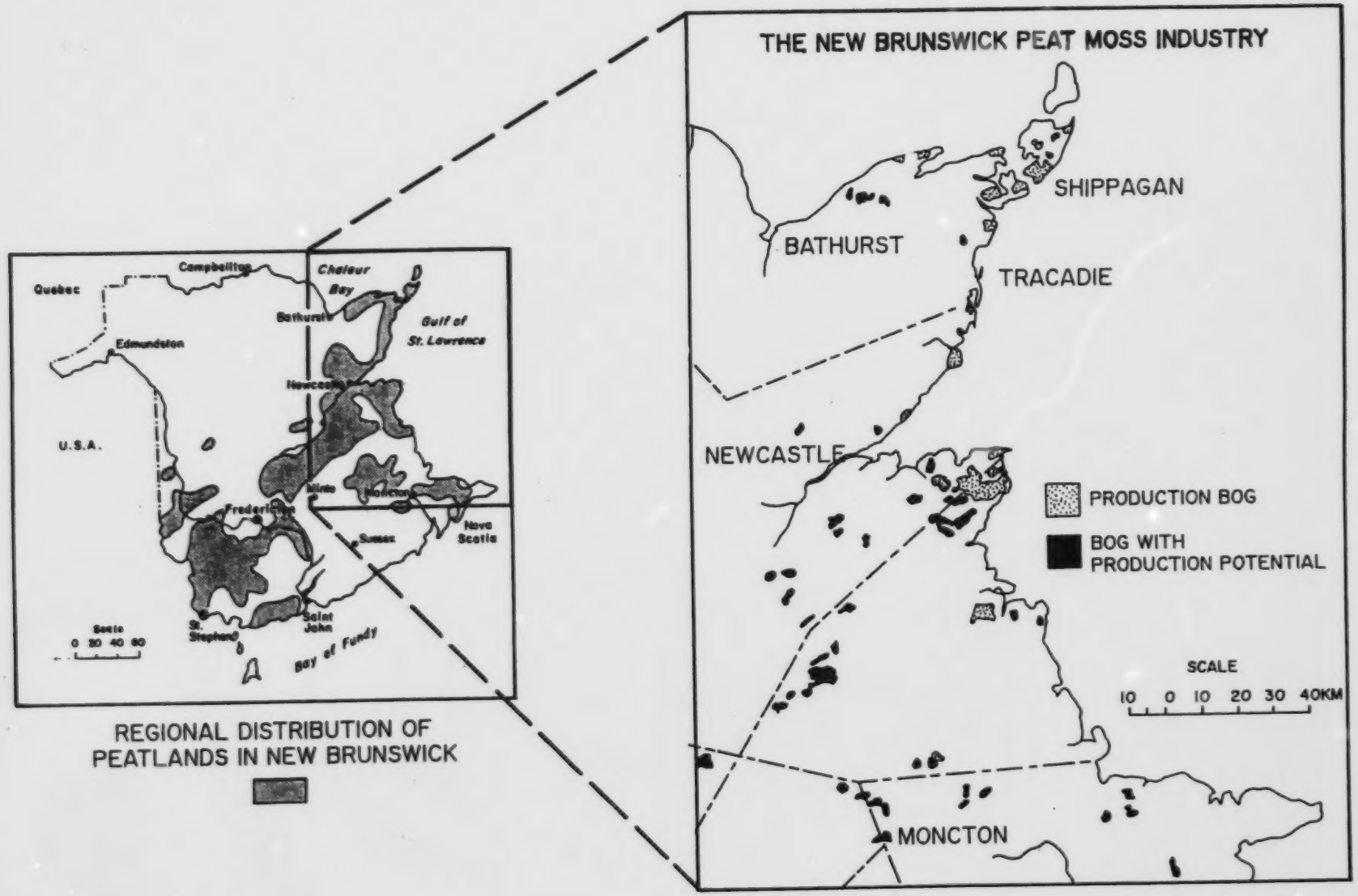
Except for a few recent investigations involving limited geolgical mapping, drilling, bulk sampling and metallurgical testing in the Woodstock, Renous and Dawson Settlement areas, active exploration for manganese has been virtually at a standstill. It would seem that this trend will continue unless an efficient and cost-effective processing technique(s) can be implemented to significantly improve the grade of known deposits. In addition, efficient marketing schemes and a variety of products, must be developed to make these deposits more competitive with foreign imports.

At present, manganese is not mined in New Brunswick. In fact, there are no significant manganese mining operations in Canada or the United States. As a result, both countries rely heavily on foreign imports.

5.15 PEATLAND RESOURCES

A peatland can be described as any bog, fen, swamp, or marsh that has a minimum accumulation of 30 cm of peat. Peat results from the accumulation of plant debris in a wet and poorly aerated environment where the rate of organic decomposition is slow. Its main properties are its high buffering capacity, low density and its very porous structure enabling it to retain up to twenty times its weight in water. Near the surface of a bog, peat is generally yellowish brown, fibrous, and only slightly decomposed (humified). With depth, the peat darkens in color and is more humified. In New Brunswick only the less decomposed peat is mined, principa'ly for its horticultural qualities.

Peatlands occupy 2% (140 000 hectares) of the Province's land surface. These lands are located within a broad diagonal band that extends from the Province's northeast corner to the southwest (Figure 5.15.1).



REGIONAL DISTRIBUTION OF
PEATLANDS IN NEW BRUNSWICK

PEATLAND DEVELOPMENT IN NEW BRUNSWICK

FIGURE 5.15.1

In New Brunswick peat is considered a quarriable substance and as such, ownership of the resource rests with the landowner. However, Approximately 65% of the identified peatlands throughout the Province are located on Crown Lands and are therefore managed by the Department of Natural Resources and Energy.

The mining of peat on a commercial scale is recorded to have taken place as early as 1894 when it was used as animal litter. Large-scale commerical extraction for horticultural use began in 1942 with the opening of peat bogs near Shippagan. Hand-cutting and stacking of peat blocks was the extraction technique most often used in the early years of production but this was gradually replaced by mechanical block cutting, and eventually a the vacuum method in the 1960's. Vacuum mining technology has increased productivity substantially, lowering production costs by about 50%. Peat mining is very weather sensitive and because the mining methods depend heavily on warm, dry sunny days to lower the moisture content of the peat in the field, rainy summers will mean lower production levels. On average, extraction is possible for only about 30 days per year, between early May and late September.

About 90% of the peat is processed as baled peat, compressed at a ratio of 2:1 and packaged in various sizes, the most popular being the 0.170 cubic metres (6 cubic feet) bag. The remainder of the production is marketed as growing substrates or potting soils with the addition of fertilizers and other products such as vermiculite and perlite.

In 1987, Canada ranked fourth in the world, in the production of horticultural peat (after the USSR, West Germany and the United States) with a total annual production of about 720,000 tonnes. The USSR accounted for 97.5% of the total world production of horticultural peat.

With less than 1% of the nation's peatland areas, New Brunswick is matched with the Province of Quebec in terms of production, accounting for about 33% of Canadian shipments of peat. In 1988, 225 000 tonnes of horticultural peat valued at approximately $30 million was shipped from New Brunswick. Twenty companies presently operate in the province, providing over one hundred full time jobs and 800 to 900 seasonal jobs to the local economy. Twenty-nine peatlands are currently under lease totalling about 4,000 hectares of surface under production. Companies operating in New Brunswick represent a mosaic of ownerships including locally owned family operations as well as others reflecting investment from the USA, the UK and West Germany, Norway and the Province of Quebec.

Eighty percent of shipments are directed to the North American market, principally the the New England States, with the balance of production being shipped overseas, mainly to Japan.

5.16 PHOSPHATE ROCK

Phosphate rock is a term applied to any rock containing significant quantities of phosphate minerals. Among the most common naturally occurring phosphate minerals is fluorapatite ($CaF_2.3Ca_3(PO_4)_2$).

All living things contain phosphorus and require phosphorus to transfer and store energy. Phosphorous maintains an important role in metabolic processes. Phosphate rock, like potash (see Potash) is a key mineral for fertilizer production. Some phosphate-bearing rocks are sufficiently reactive, and can be crushed, ground and applied directly to farm fields, providing a slow-release source of phosphorus. Most fertilizers, however, require a much more reactive form: phosphoric acid, normal superphosphates, or triple superphosphate. These materials then serve as ingredients in the production of most blended fertilizers.

Most phosphoric acid is produced from phosphate rock by treating with sulphuric acid. The key reactions are:
phosphate rock + sulphuric acid + water yields phosphoric acid + phosphogypsum + hydrogen fluoride. The phosphoric acid is neutralized with ammonia to form diammonium phosphate or DAP. DAP contains nitrogen and phosphate, two basic fertilizer materials which when combined with potash provide plants with important source of nutrients. All phosphate rock consumed in Canada is imported, over 90 percent from the United States (70 percent from Florida alone). About two-thirds of imported phosphate rock is used in the manufacture of basic fertilizer ingredients, with the remaining one-third used for elemental phosphorus production. Elemental phosphorus is used in the formulation of a wide variety of chemicals, the most common of which is consumed in water treatment and detergents where phosphorus salts remove lime and magnesia from water thereby softening it which aids in emulsifying and dispersing solids.

Phosphate rock is not mined in New Brunswick or in Canada for that matter. Brunswick Fertilizer, a division of the Brunswick Mining and Smelting Corporation Limited (BMS) currently imports about between 250,000 and 300,000 tonnes per year. The material arrives at their Belledune operation in northern New Brunswick by sea from Florida. The fertilizer plant, founded in 1966, treats this imported phosphate rock with excess sulphuric acid (H_2SO_4) generated at the nearby BMS smelter to produce phosphoric acid. The acid is reacted with ammonia obtained from Ontario to produce diammonium phosphate (DAP).

Diammonium phosphate or DAP has an NPK (where N is the percent elemental nitrogen (N), P is the phosphate content (P_2O_5), and K is the potash content (K_2O)) ratio of approximately 18-46-0. The fertilizer plant is also capable of producing monoammonium phosphate with an NPK ratio ranging from 16-48-0 to 11-48-0. Brunswick Fertilizer produces approximately 300,000 tonnes of DAP per year and employs up to 150 people.

This product is sold to retail fertilizer producers who add various other fertilizer materials to produce the type of fertilizer required by the consumer. Eastern Canada consumes about a significant proportion of the yearly production. The balance is distributed to fertilizer markets throughout the world.

The production of phosphoric acid creates several interesting by-products. Every tonne of phosphoric acid produced results in about three tonnes of waste phosphogypsum. This material however, contains various impurities originally present in the phosphate rock. In some cases, these impurities can be economically removed. Although the Belledune operation has investigated several options pertaining to the utilization of this by-product it has yet to develop a viable market for this material.

5.17a POTASH its use, origin, mining, processing and marketing

...Use

Naturally occurring potash, a source of the element potassium (K), is one of the world's most important mineral resources. Since potassium is an important nutrient that all plants need, it is one of the main ingredients of most fertilizers used in modern agricultural practices. When purchasing commerical fertilizer, perhaps you have noticed a number formula, for example 10-10-10, printed on the package. This simply refers to the percentage of nitrogen, phosphorus, and potassium (or potash) respectively, that is contained within.

Canada has slightly over one half of the world's demonstrated potash reserves and is the second largest producer in the world, behind the U.S.S.R. Almost 90 percent of our nation's production originates from ten mining operations centered in the extensive deposits of southern Saskatchewan. The balance of production comes from New Brunswick where two mine and milling facilities were established in the mid 1980's.

...Origin

The name potash is derived from an old method of producing potassium by leaching wood ashes with water and evaporating the resulting solution in a large iron pot. The residue left behind in the pot after this process was called "potash". It is obvious that producing potassium in this way was a tedious and a time-consuming endeavour.

Over 140 years ago naturally occurring potash was discovered in Germany. Most significant deposits of potassium are found combined with other elements in buried salt deposits. For example, deposits are typically found in combination with chlorine, forming potassium chloride (KCl), often referred to as muriate of potash. New Brunswick has been well endowed with this important mineral resource. There are three confirmed deposits all at various stages of exploration and development within 25 km of Sussex (Figure 5.17a.1), a town of about 11,000 people, located in Kings County in the southeastern part of the Province.

Some 320 million years ago, a vast sea covered much of what is now southeastern New Brunswick. Under arid, or even desert-like climatic conditions believed to have existed at that time, sea water containing an abundance of

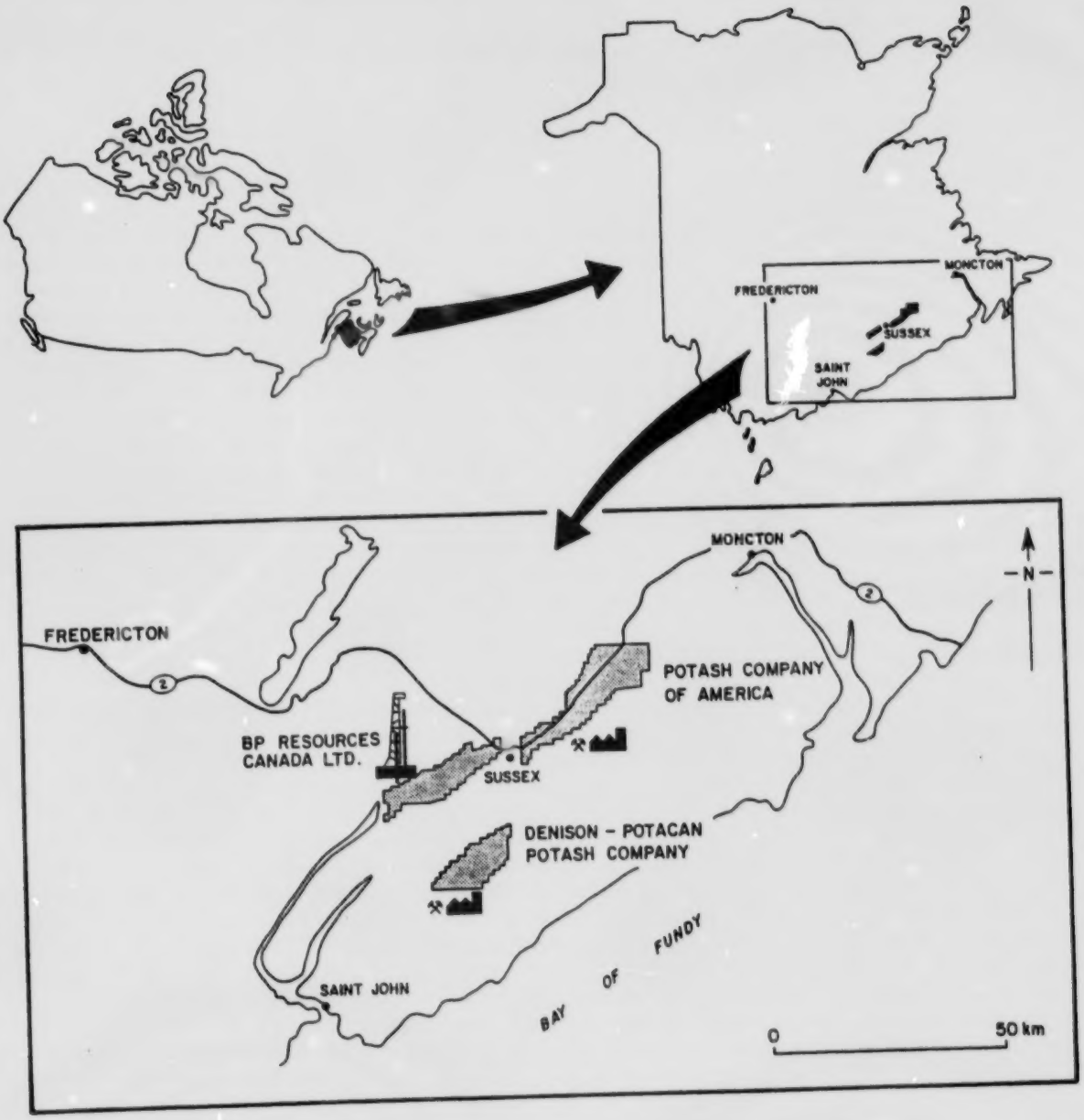


Figure 5.17a.1 Potash mining leases in New Brunswick.

dissolved sodium, potassium and magnesium salts, slowly started to evaporate. As water volumes decreased during the evaporation process, various dissolved salts could no longer be carried in solution and soon began to settle out on the sea bottom, building up vast layers referred to evaporites. The sodium salts settled out first followed by potassium and magnesium salts. Eventually, the sea withdrew from this part of New Brunswick and during succeeding geologic time, evaporites became buried by thick deposits of mud, sand, and gravel, later to be compacted into the sedimentary rocks; siltstone, sandstone, and conglomerate. As a result, New Brunswick's potash and salt deposits are hidden from view, at depths up to 900 metres below ground level.

Typically potash-bearing evaporites are stratified into layers. The spatial relationship of these layers to each other and the surface of the ground is function not only of the way in which they were originally deposited but is also a function of post depositional alteration which can result in changes to the original mineralogy and changes to the original geometry of the deposit. In some cases evaporite deposits have remained largely undisturbed; in others they have been highly deformed by folding and faulting of the earth's crust. In New Brunswick later geological processes have somewhat distorted our evaporite deposits to the point where portions of the sought after potash bed(s) are tilted at fairly steep angles. Such distortation can result in a variation in bed thickness from one part of the deposit to another.

...Mining

The high solubility of evaporites make open pit mining of potash deposits impractical. Although it is possible to recover potash by underground leaching or solution mining via a drillhole, it is seldom pursued except under ideal conditions.

For the most part, potash deposits are exploited by conventional underground mining techniques. The earliest potash mines in the world were developed mainly by drilling and blasting and one New Brunswick mine still uses this method in conjunction with a more modern excavation techniques. Of several modern methods commonly employed, modified room-and-pillar and cut-and-fill methods are applied to New Brunswick deposits.

The use of waste rock or "tailings" from the potash refining process, as backfill, is an essential part of both mining methods, serving two functions: as support to mine stability and as an acceptable means of waste disposal since tailings are not permitted to be stored on surface due to potential risks to the environment.

Room-and-pillar mining is centered around the establishment of a network of roadways or interconnected "rooms" in the potash zone on a rectangular plan; excavating the ore from these rooms and leaving a number of rectangular pillars for roof support. The size of the rooms and adjacent pillars depend on the competency of the overlying strata. Clearly, from the point of view of maximum resource recovery, the smaller the pillars are the better. Rooms are later backfilled with tailings to eventually facilitate further pillar extraction.

The cut-and-fill method is mainly confined to steeply dipping potash beds. Essentially it involves mining an ore body in an longitudinal direction while the mined or cut area behind the excavation machinery is backfilled with tailings.

Both New Brunswick mines make extensive use of continuous mechanized cutting machines to extract potash ore. These machines often referred to as continuous miners combine the function dislodging soft potash ore from a working face in the mine and collecting the debris onto a conveyor system. Although there are several types of machinery in use throughout the world, the configuration of New Brunswick potash deposits requires those of the boom (roadheader) type for efficient and cost effective rates of extraction (Figure 5.17a.2). Each New Brunswick potash producer possess several of these boom type miners. Essentially these machines consist of a rotating cutting head, mounted on the end of a boom which can be raised, lowered and slewed from side to side. In operation, the machine is moved forward on tracks until its' cutting head, bearing a series of picks, bites into the ore face. These machines are generally capable of excavating 2900-4000 tonnes/day depending on geological and other conditions encountered in the mine. They are capable of cutting a working face 6.5 metres high and 12 metres across, consistant with New Brunswick potash companies preferred practice of mining in wide, high caverns or slopes.

Excavated material falls onto and in front of a loading apron where mechanical "arms" gather it onto an adjacent network of conveyors. The broken ore is then transported to the production shaft where it is hoisted to the surface via a large self-dumping type bucket (skip) with a capacity of up to 25 tonnes.

...Processing

As it comes from the mine, the potash ore is in large pieces containing approximately 40% potash, 55% salt and up to 5% clay and other contaminants. The ore must be further refined, in a mill facility, to separate the potash from the unwanted salt and other impurities mixed in with it. To accomplish this, the ore is first crushed and a salt brine is added to create a viscous semiliquid slurry. The salt and potash particles in the slurry are then agitated in large tanks to wash clay particles off the ore particles. Such a process, called "desliming", can be compared to washing soiled clothing in a washing machine. In this analogy a combination of soap bubbles and water agitation emulsify and carry dirt to the surface of the wash water where it can be drained off. Following desliming, potash and salt particles are further separated by a process referred to as flotation. During this phase of refining various chemicals are added to the salt-potash brine mixture which is pumped into tanks called flotation cells. Air is injected into the bottom of the cells causing bubbles which rise to the surface. The chemicals previously added, coat the potash particles causing them to cling the outer surface of each air bubble much the way metal is attracted to a magnet. The potash bearing air bubbles rise to the surface where they are skimmed off. Salt particles unaffected by the chemicals, remain in the slurry to be later drawn off and disposed of as tailings. The concentrated potash particles are then dried and size classified generally into four categories: granular (0.80 to 4.7 mm); coarse (0.60 to 3.3 mm); standard (0.21 to 1.7 mm); and fine (0.11 to 0.80 mm).

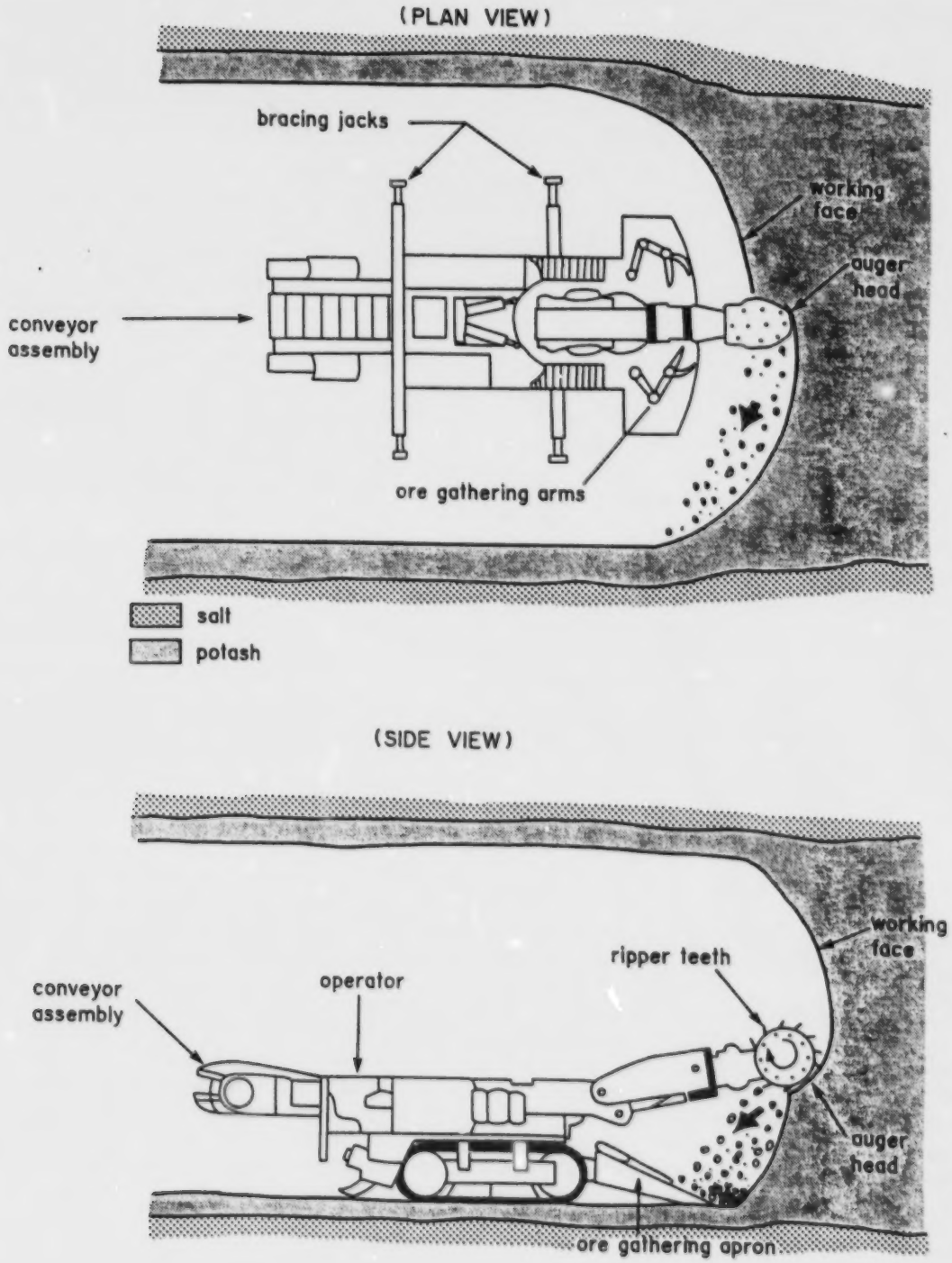


Figure 5.17a.2 Typical boom (roadheader) type continuous mining machine commonly used in New Brunswick potash mines.

...Marketing

Once mined and refined, the finished potash products are ready for transport via rail to the nearby shipping and storage facility at Saint John from where it is marketed around the world. In 1987, a significant proportion of New Brunswick potash was exported to western Europe, the United States, Central and South America, Asia and Oceania.

5.17b "I believe we've cut some potash"

This simple statement in 1971 by J. K. Worth, project geologist in charge of a government-sponsored salt drilling program near Sussex - has turned out to have been somewhat of an understatement. This initial indication of potash mineralization has subsequently resulted in the establishment of a dynamic new industry in the Province - a multi-million dollar per year industry providing direct employment for several hundred New Brunswickers and contributing millions of dollars annually to the Provincial treasury. In fact, potash accounted for over 50 percent of the total revenue (through taxes and royalties) realized by the Province from it's mineral and energy resources in 1988. A similar share of total revenue is projected for 1989.

The presence of potash mineralization in New Brunswick and other parts of Atlantic Canada had long been suspected prior to 1971. This suspicion was based on the confirmed occurrence of high-order marine evaporites at various locations and the presence of numerous brine springs, bearing anomalous dissolved concentrations of the element potassium.

Although the region appeared to show considerable promise, there was little interest in extensive potash exploration projects. A number of factors contributed to this apparent lack of interest. The overshadowing impact of the rapid development of potash resources in Saskatchewan (discovered in 1942) prior to 1970 probably played a significant role in deterring exploration in this part of the country. In addition a preliminary survey of available geologic literature in the early 1960s indicated that, if found, a potash deposit in New Brunswick would probably be of limited extent, and insufficient economic grade and thickness. It was also perceived that any potash discussed would be found at depths considered prohibitive to cost effective mining. Oversupply of potash on the world markets throughout much of the 1960s also discouraged exploration. All these factors, combined with a lack of well defined targets, made exploration an extremely risky venture - a risk, most at that time, were unwilling to accept.

Toward the end of the 1960s, the viability of establishing a chemical industry west of Saint John became a topic of some interest and concern to the New Brunswick Government, eager to expand the industrial base of the Province's economy. One of the prime requirements of such an industry was the availability of high-grade salt, a basic ingredient in many chemical processes (see Salt section).

To identify a nearby source of salt, provincial government geologists outlined a number of exploration targets in the vicinity of the town of Sussex. Areas proximal to major transportation links with Saint John were given priority. A salt drilling programme was eventually established late in 1970, jointly funded by the Canada Department of Regional Economic Expansion (DREE) and the New Brunswick Department of Natural Resources (DNR).

Early in 1971, two holes were drilled in an area just east of the town into what was perceived as an elongated subsurface salt structure. Although both holes intersected high-grade salt, the first potash was intersected in a hole drilled near Plumweseep. In Plumweseep No. 1, a cumulative thickness of 20.7 meters of potash (sylvinite) averaging 23.7% K_2O was intersected between 277 and 305 m below surface.

The unexpected success of the Plumweseep hole coupled with an improvement in the supply/demand situation in world potash markets prompted the New Brunswick Department of Natural Resources to carry out additional potash exploration in 1972. By utilizing gavity methods, a number of anomalies were delineated in areas thought to be underlain by subsurface salt structures. This work led to the drilling of three more government-sponsored holes in 1973, all within a 30 km radius of the first discovery hole. Subsequently, potash was discovered in the Cassidy Lake-Salt Springs area and near Lower Millstream. A hole drilled 30 km southwest of Sussex at Salt Springs intersected a substantial thickness of potash, averaging 31.6% K_2O between 607 and 623 m below surface. The Lower Millstream hole, situated less than 10 km west of the town, confirmed the presence of potash bearing evaporites at 925 m, but results were somewhat inconclusive as to its extent.

5.17c General geology of New Brunswick potash deposits

New Brunswick potash deposits are about 320 million years old, deposited in during a period of time geologists call the Mississippian age. Associated with Windsor Group marine sediments, potash was deposited in a number of ancient subbasins within a broad regional basin referred to as the Martimes Basin. This depositional setting covered a large part of Atlantic Canada, extending in a northeast direction from southern New Brunswick, through northern Nova Scotia to the southwestern shores of Newfoundland (Figure 5.17c.1).

In southern New Brunswick the Windsor Group consists of a sequence (up to 300 m thick) of limestone successively overlain by anhydrite (gypsum), halite (rock salt) and sylvinite/carnallite (potash), collectively referred to as evaporites. Capping these evaporites are claystone and clastics (Figure 5.17c.2). New Brunswick potash deposits have been known to attain a thickness up to 30 m thick locally and occur at depths up to 1000 meters below surface. The Province's insitu potash ore reserves are estimated to exceed 500 million tonnes.

Potash beds have been subjected to varying degrees of internal folding. Although initially perceived as a possible deterrent to cost-effective mining, subsequent underground exploration and development have indicated that the scale and complexity of folding lie well within manageable limits. In general potash ore grades range from 22-28% K_2O.

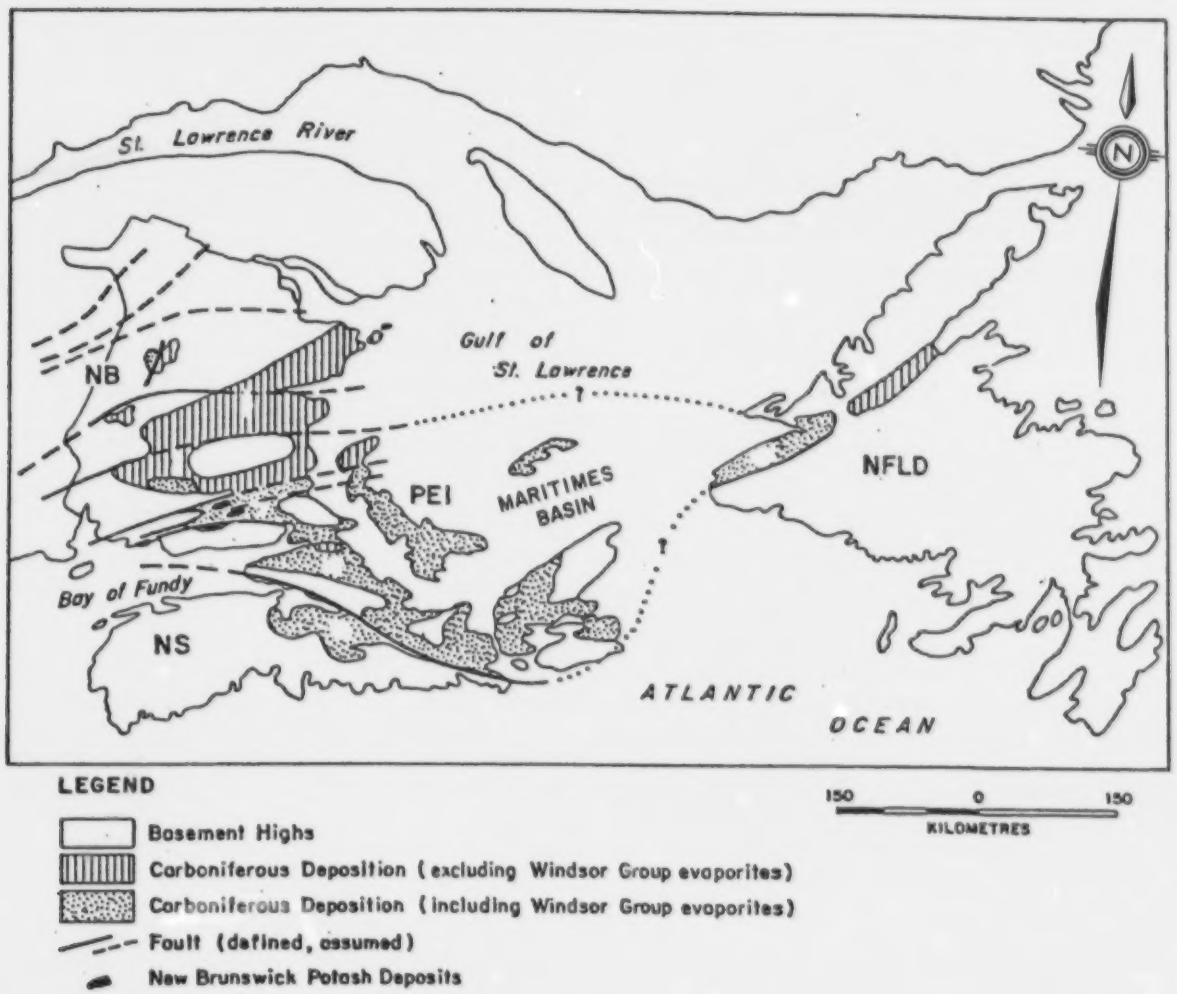


Figure 5.17c.1 Windsor Group rocks underlie a large part of Atlantic Canada.
(after Schenk 1969; Kelly 1967; Wade et al. 1977; and Martel 1987).

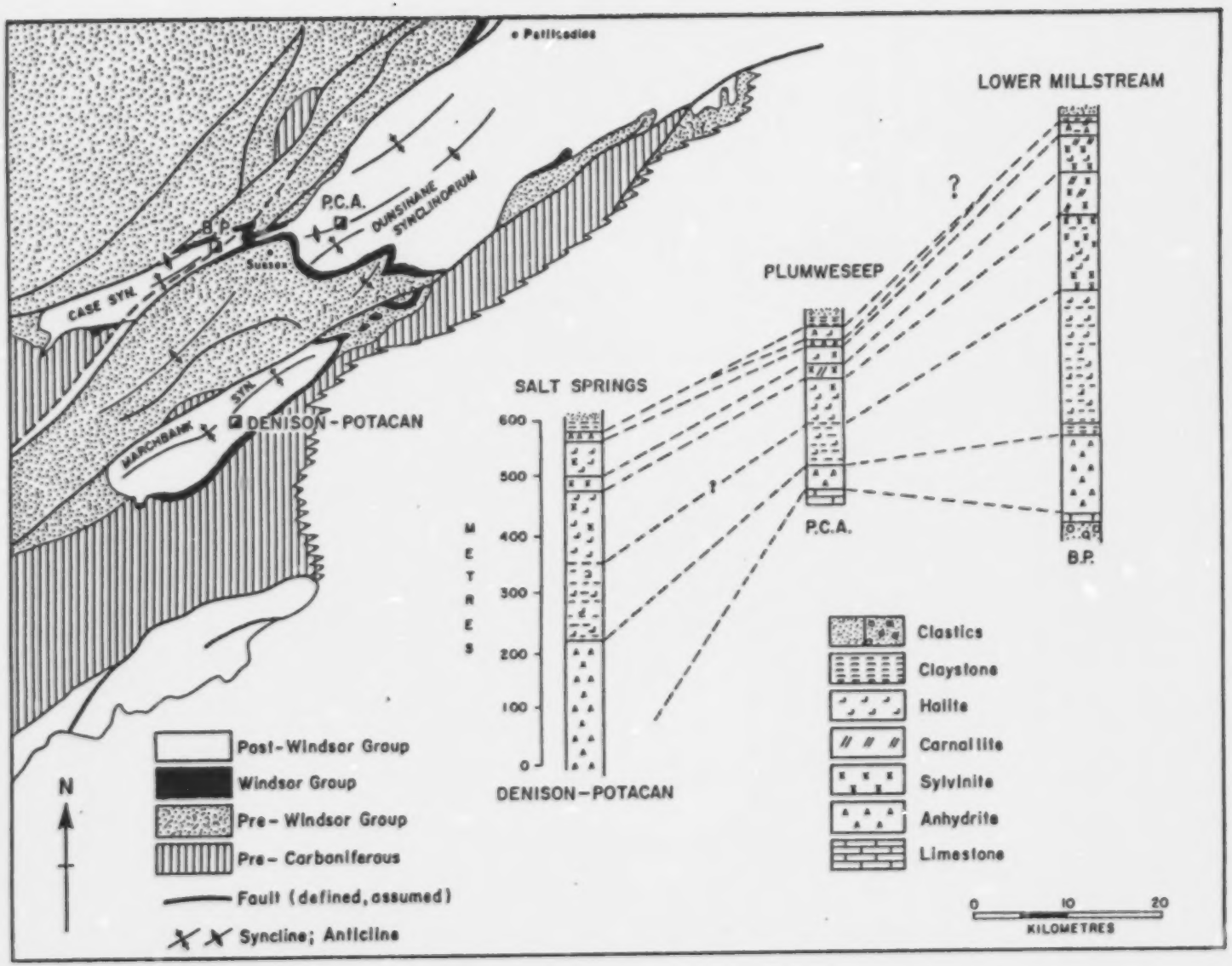


Figure 5.17c.2 General stratigraphic relationships of Windsor Group evaporites in the Sussex area of southern New Brunswick.

5.17d Potash resource policy

Following it's initial discovery in 1971, the New Brunswick Government opted to invoke crown ownership over all mineral rights to potash and related minerals throughout the entire Province. In effect, this removed these minerals from the traditional prospecting and claim staking procedures set out in the Province's Mining Act. This action was prompted by geological concerns over the extent of the recently discovered potash deposit at Plumweseep. There was a general consensus from those involved at the time that normal prospecting and staking procedures were inappropriate for potash exploration and could actually be detrimental to responsible resource development.

For almost two decades the Province's objective regarding its indigenous potash resources has been to foster efficient, and orderly exploration and development of this important mineral commodity (Figure 5.17d.1).

A policy of inviting interested companies to bid on exploration and development rights for selected potash reservation areas has been adopted. This process has subsequently resulted in three companies entering into mining lease agreements with the Province since 1973.

5.17e Potash developments in New Brunswick

In 1988 potash ranked number one in gross dollar sales of all nonmetallic (industrial) minerals produced in New Brunswick. In fact potash contributes 10 to 15 percent towards the total value (nonmetallic and metallic) of all minerals mined and sold. The industry currently directly employs over 800 people. With a combined capacity of 1.8 million tonnes of product (muriate-KCl) per year, New Brunswick potash mines constitute just over 10 per cent of total Canadian capacity. Approximately 1.5 million tonnes product were shipped through the port of Saint John in 1988. These shipments span the globe.

Two of the three companies involved with potash development in the Province operate mines along with associated processing and port storage facilities. A third company, which signed a mining lease with the Province 1985, has undertaken a feasibility study prior to making a decision to proceed on shaft sinking and underground exploration. Both are necessary before a production decision can be made.

POTASH COMPANY OF AMERICA (a Division of Rio Algom Ltd.)

The Sussex area mine and concentrating facility of the Potash Company of America (PCA) was the Province's first potash mine, establishing operations in 1983. In addition to the mine and concentrating facility, the company operates a potash shipping terminal at Saint John, less than 80 km to the southwest.

PCA signed a mining lease with the Province in June of 1978 covering an area of 19 187 hectares. The agreement in effect for an initial period of 21 years has renewal options for three successive 21-year periods. Among the terms

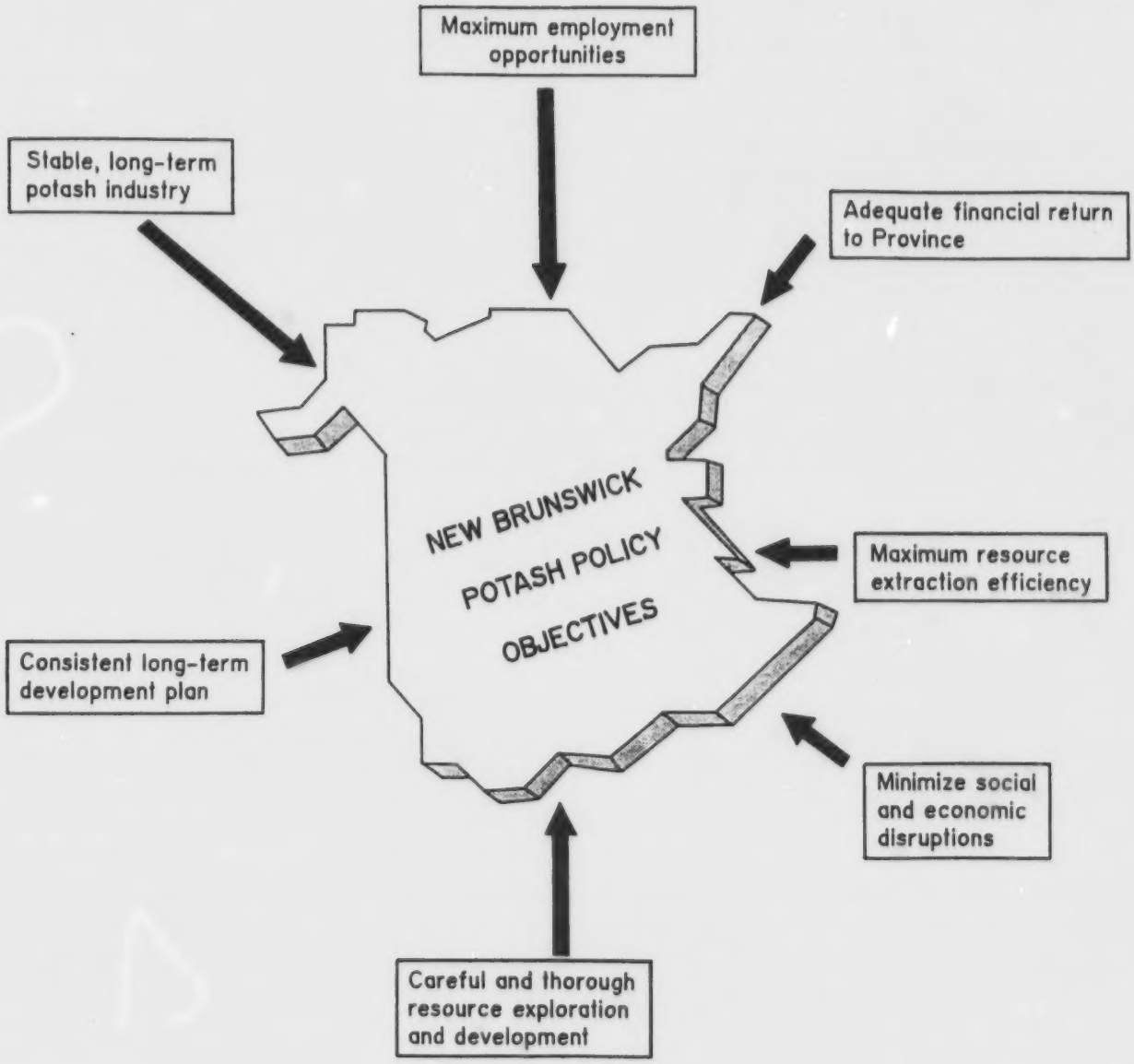

Maximum employment opportunities
Stable, long-term potash industry
Adequate financial return to Province
NEW BRUNSWICK POTASH POLICY OBJECTIVES
Maximum resource extraction efficiency
Consistent long-term development plan
Minimize social and economic disruptions
Careful and thorough resource exploration and development

Figure 5.17d.1 New Brunswick has adopted a potash policy to ensure an efficient and structured approach to resource exploration and development

of the lease it is stipulated that a royalty of 6 1/4% of the sales price of standard grade product (f.o.b. mine site) is payable to the Province on a quarterly basis.

Initial development at PCA began in 1978 with the construction of the first of two 610 m shafts. The mine/mill construction phase was completed within 6 years. At the peak of construction (1982-83), a work force consisting largely of contract employees, numbered approximately 720 persons. By 1988, this number has been reduced to an average permanent workforce of about 340.

At PCA, mining is carried out by cut-and-fill procedures employing continuous mining machines. This method was adopted because of the configuration of the orebody and the requirement of disposing of tailings underground to comply with environmental regulations.

After the ore is brought to the surface, it is processed utilizing advanced technology and equipment. The mill produces four grades of potash: granular, coarse, standard and fine. High-grade salt adjacent to the potash orebody is also mined and sold in order to accommodate the underground storage of tailings and brine from the refining process. Up to 500,000 tonnes of chemical and road-grade salt is marketed each year.

The processed potash is stored in covered warehouses both at the mine site and at the Port of Saint John. The combined storage capacity is more than 200 000 tonnes.

During the start-up phase in 1983, initial production was at levels considerably below the mine's rated capacity of 380 000 tpa K_2O equivalent (635 000 product tonnes). By 1984, the level of production had reached only 40% of design capacity. In January 1986, Rio Algom Limited purchased PCA from its parent company, Ideal Basic Industries Inc. The new owner, committed a substantial amount of money to improve the operation's efficiency. This action has lead to a significant improvement in product output. Production figures for 1988 indicate the mine operated near 87 per cent of its rated capacity. In fact PCA may be capable of further expanding annual productive capacity in the 1990s, placing it in a good position to take advantage of forecasted improvements in world potash demand.

DENISON - POTACAN POTASH COMPANY

In 1979, Denison Mines Ltd. was assigned the rights to a 8 887 hectare mining lease covering the Clover Hill potash property (formerly the Salt Springs property), which had been purchased from International Minerals and Chemical Corporation. In 1980 the Denison-Potacan Potash Company (DPPC) was established. DPPC is a joint enterprise, in which Denison Mines Ltd. (60% interest) is Manager of Operations and Potash Company of Canada (Potacan; 40% interest) is Manager of Marketing. Potacan is owned equally by West German and French interests.

Denison-Potacan commenced production at its Clover Hill mine site in July, 1985, after nearly six and one-half years of shaft sinking, exploration and construction.

The mine has a rated capacity of about 780 000 tonnes K_2O (1 300 000 product tonnes) and employs a regular workforce of about 450 people.

Modified room and pillar mining methods employing both continuous mining equipment and, to a lesser extent, drill and blast technology, are used to extract ore from zones 2 to 23 m thick, several hundred metres below surface.

The mill produces four product grades: standard, coarse, granular and fine. A central computerized control system is utilized to monitor all facets of mill operation. In 1988, DPPC managed to achieve production levels near 80 percent of the mine's design capacity.

Potash is transported from the mine site via a 20 km spur line that links the property to the main Moncton-Saint John C.N.R. railway line to the west. At the Port of Saint John, a 115 000 tonne storage building has been erected. The rail-unloading and ship-loading facilities are shared with PCA. Ship-loading facilities are designed to handle shipments up to 35 000 tonnes.

BP RESOURCES CANADA LIMITED

In February 1981, BP was awarded the potash exploration rights for an area of 10 125 hectares near Lower Millstream, 10 km west of Sussex. The three-year exploration agreement called for drilling three holes, minimum expenditure of $750 000, commitment to the 6 1/4% potash royalty, and 21.1% share of net cash profit after earning a 15% return on investment. A one-year extension to the exploration agreement was granted in January, 1984, to enable completion of the programme.

Eleven exploration drill holes, one shaft pilot hole and several detailed geophysical studies have been completed to date on this property. Numerous zones of potash mineralization have been encountered between 950 and 1051 m below surface. Preliminary tonnage and grade estimates on at least two zones appear very encouraging.

BP prepared a preliminary feasibility study and signed a mining lease with the Province in July, 1985. To date, the company has made no decision on sinking an exploration shaft and conducting an underground exploration programme. This is necessary prior to any production decision. BP is actively searching for a partner, to take equity in the Lower Millstream Project.

5.17f New Brunswick Potash - Advantages and Opportunities

At present, New Brunswick's potash production capacity, about 1 170 000 t K_2O equivalent, relates to approximately a 10% share of total installed Canadian production capability.

The level of capital investment in the Province's potash industry has been, and should continue to be, significant. Combined public and private sector expenditures of millions of dollars since the early 1970s have been a valued stimulus to the provincial economy. During peak construction phases, potash mine/mill development has resulted into more than 1000 well-paid jobs per mine. In the present post-construction or operational phase, combined average employment levels at the two existing mines have been steadily maintained at approximately 800 people.

Future potash-related development in New Brunswick and throughout the world is directly proportional to "growth" within the agricultural sector. In the mid 1980s, the North American potash industry suffered from high inventories, soft market conditions, and low prices. Despite the apparent uncertainties and fluctuations of world markets, New Brunswick potash producers and would-be producers can look optimistically to the future. The proximity (less than 70 km) to the all-weather Port of Saint John, should ultimately give the Province's producers a substantial competitive edge in certain market areas. Our favourable geographic location places the Province in a particularly strong position for significant market penetration of the eastern seaboard of the United States and other offshore destinations such as Western Europe, Central and South America and Asia.

With some potash mines throughout the world faced with depleting reserves, increased production costs, and other production problems. New Brunswick producers should be able to take full advantage of any potential shortfalls in supply that could eventually develop in North American and other offshore markets.

Most market observers appear to agree that world potash demand may increase from the present annual consumption of about 30 million tonnes K_2O to approximately 34 million tonnes K_2O by the mid 1990's. With world potash production capacity projected at 36.5 million tonnes by 1997 it is expected that supplies could become tighter since most potash mines seldom operate at 100% capacity for sustained periods. At this projected rate of increased consumption, it has been postulated that installed and planned Canadian production capacity could be completely utilized within the next 6 or 7 years, requiring additional productive capacity to be installed. Any additional expansion plans will certainly have an impact on the Province's potash industry. The most recent period of market instability has no doubt, played a significant part in delaying the decision by BP to proceed with further evaluation of their Lower Millstream property - a decision that could result in additional capital expenditures upwards of $400,000,000 and eventually expand the Province's potash production capacity in excess of 1 700 000 tonnes K_2O per year (about 3 million tonnes of product) by the turn of the century.

If world market demand expands as predicted, there could even be a renewal of interest in grass roots exploration for potash in various part of the Province. One potential exploration area occurs in the extreme southeastern part of the Province. Although subsurface evaporites similar in part to those of the

Sussex area occur in the region and trace amounts of potash have been verified in the region, the presence of significant potash mineralization cannot be determined at this time because of the rather limited amount of reliable geologic information available. However, some of the initial geological indicators for a potential deposit are clearly present.

5.18 SALT

Salt, the common word for the mineral halite or sodium chloride (NaCl), has been used by man from times immemorial. To most of us salt is most visible at meal times, but this use actually accounts for only a small fraction of total consumption. Although there are literally thousands of uses for salt the major ones can be separated into four or five broad categories. In North America, two of the largest uses are in the manufacture of industrial chemcials; and as road salt, widely used to melt snow and ice.

The industrial chemical manufacturing industry is by far the largest consumer of salt. Often referred to as the chlor-alkali industry, salt form the basis of many chemical processes involving the production of chlorine (Cl), caustic soda (or sodium hydroxide, NaOH). soda ash (sodium carbonate, Na_2CO_3) and numerous related chemicals.

In New Brunswick there are two chlor-alkali manufacturing facilities. The St. Anne Chemical Company Ltd. at Nackawic produces chlorine caustic soda, sodium chlorate and hydrochloric acid. The product is captively consumed by adjacent pulp and paper mill. A second chlor-alkali producer, located in Dalhousie is operated by CIL Inc. It produces chlorine, caustic soda, hydrochloric acid and hypochlorate.

Salt is very soluble and when added to water the freezing point of the resultant solution is lowered by several degrees. This property makes salt a particularly effective de-icing agent and it is used extensively on roads during the cold winter months in Canada and the northern United States.

Few living organisms can survive in a highly saline environment, this property therefore makes salt a useful food preserver. Early New Brunswick settlers placed a high value on salt because of its food preservation properties. At one time most of the salt consumed in eastern Canada was imported from England. There was soon limited and sporadic salt production for local use from numerous the salt springs situated in the southern part of the Province. Production appears to have started around 1800 and continued until about 1905 at several areas. Salt mining opertions eventually became well established in Nova Scotia and Ontario, providing a ready domestic supply of salt. There was little incentive to create competitive operations in New Brunswick.

New Brunswick salt deposits are of Mississippian age. They are found in association with sediments of both continental and marine origin and appear restrict to the southeastern part of the Province. Deposits associated with continental sediments are considered to have originated from the evaporation

of local playa lake waters. Exploration drilling has intersected this type of salt at only two locations. In each case the salt was found to be interbedded with varying amounts of shale. Such deposits are considered to be of inferior quality for most salt applications.

The most prominent salt deposits in the Province are those associated with marine sediments. The most notable deposits occur in the Sussex and the Dorchester-Tantramar areas. In contrast to the continental salt deposits these deposits tend to be more extensive, thicker and of superior quality.

Toward the end of the 1960s, the viability of establishing a chemical industry west of Saint John became a topic of some interest and concern to the New Brunswick Government. One of the prime requirements of such an industry was the accessibility of large volumes high-grade salt.

To identify a nearby source of high quality salt, Provincial government geologists outlined a number of exploration target areas in the vicinity of the town of Sussex. Areas proximal to major transportation links with Saint John were given priority, and a subsequent drilling program was undertaken early in 1971.

Two holes were drilled in an area just east of Sussex into what was percieved to be an extensive, subsurface salt structure. Although both holes intersected high-grade salt, one hole near Plumweseep intersected potash mineralization. With the unexpected intersection potash, salt now took on a secondary importance and was soon replaced as the target mineral in subsequent exploration in the Sussex area. Potash exploration has resulted in the establishment of two potash mines; one operated by the Potash Company of America (a Division of Rio Algom Ltd.) and the other operated by the Denison Potacan Potash Company. There also remains the possibility of a third mine being developed by BP Resources Canada Limited. Additional information on the potash developments are provided in the Potash section of this booklet.

In New Brunswick deposits of salt found in association with potash deposits typically can be grouped into several "zones" reflecting broad differences in purity. Zones of high grade or "clean" salt; zones impure argillaceous salt; zones of anhydritic salt; and other zones containing minor amounts of potash, are among the most common. Potash ore by itself is typically comprised of a mixture of the potash mineral sylvite (KCl) and salt, in the form of the mineral halite (NaCl). The higher the percentage of sylvite in the mixture, the higher the grade of the "potash ore".

In order to meet the specifications of the marketplace the potash and salt must be separated. This is accomplished by using a series of chemical and mechanical methods to extract the potash only, from the ore. The salt which remains, together with some other impurities, is referred to as "tailings"; waste rock which must be disposed of in an environmentally acceptable manner. The obvious solution to tailings disposal would be to sell the salt in the marketplace. However, the finely ground, impure material does not represent a high quality product, particularly for use by the chemical industry, and does not often meet with market acceptance.

Environmental regulations do not permit the simple unprotected stockpiling of salt tailings on surface in New Brunswick. Tailings are therefore returned underground to backfill space created during the potash mining operations. The crushing and processing of the potash ore greatly increases the volume of its waste materials and only limited space is available underground for disposal of these and other waste products. Disposal of excess brine generated during the potash concentration process represents a substantial problem to New Brunswick mining operations. Several possible solutions to the problem are recognized. The Denison operation utilizes a pipeline to transport such solutions to the Bay of Fundy where it is diluted and released in an acceptable manner into the sea. At PCA a somewhat unique approach has been undertaken. One section of mine, a considerable distance from the main potash ore zone, is mined exclusively for high purity salt. This material is of sufficient quality to compete against the product from other producing salt mines in the eastern Canada and the northeastern United States. The salt, mined by a cut and fill method is brought to the surface through the existing infrastructure utilized for the potash operation. The additional open space created by salt extraction can then be used for excess tailing and brine disposal.

Salt has been produced and sold by PCA since 1980, at a rate of 400 000 to 500 000 tonnes per year. It is sold mainly in the eastern United States for road de-icing and some chemical manufacture.

5.19 SILICA

Silica (SiO_2) occurs as the mineral quartz in numerous rocks and unconsolidated sediments. Although it is a very abundant mineral, commercial sources of silica are typically restricted to only high purity deposits, namely quartzose sandstone, quartzites, and unconsolidated quartzose sand. Less common sources include diatomite, vein quartz, and a by-product of feldspar and kaolin mining. Compared to other mineral commodities silica has a relatively low unit value, and is typically mined by low-cost open pit methods. Transportation is a major factor in its delivered cost. Proximity to consumers therefore enhances the viability of production.

Silica products are generally available in three major size categories: lump silica (greater than 5 mm), silica sand (5 mm and finer), and silica flour (very fine). Its uses are many and include: glass and fiberglass manufacture; metallurgical flux in smelters; manufacture of silicon carbide (SiC); as an ore of silicon (Si) and ferrosilicon (FeSi); as foundry sand for metal castings, in sandblasting; and as a mineral filler in a host of manufactured products including paint, plastics, caulking compounds, buffing compounds, cleansers and abrasives, bricks and concrete blocks and specialty cements. Although silica has many uses the "lions share" of production is consumed by relatively few industries. In Canada (1985), four industries account for over 80% of silica consumption: glass manufacture (27%); percent; smelter flux, (34%); foundry sand, (14%); and chemicals, (6%).

Over 25 deposits of naturally occurring siliceous materials (excluding beach sand) have been documented throughout New Brunswick. While most of these deposits are impure, a few locally attain grades high enough to qualify them as an industrial source of silica depending on the intended end use.

Quartzite of potential economic significance, occurs within the Precambrain rocks in the southern part of the Province. Ordovician and Silurian quartzites are found in central and western New Brunswick. Quartzitic sandstones occur in the Carboniferous rocks near Bathurst and Moncton. Other sources of silica, in the form of thick quartz veins are present at numerous localities, the most prominent of which occur along the Province's Bay of Fundy coast. A unique deposit of unconsolidated siliceous sand and gravel is situated about 22 kilometres southwest of Sussex, in Kings County.

The first commercial production of silica in New Brunswick began in 1974. About 10 000 tonnes were produced that year from a deposit near Bathurst and used as a flux by the lead smelter at Belledune on a trial basis. Gradually production was increased over a ten year period.

Up until recently, there were two silica mines operating in the province. A quarry at Bass River, about 7 km east of Bathurst, provided raw material supply for the Chaleur Silica Ltd. operation. Although Chaleur's principal market was flux for the Brunswick Mining and Smelting Corporation Limited smelter other products included blasting sand, nursery sand, a cement additive, and a component in manufacturing non-skid floor surfaces. The Chaleur quarry was acquired by Elmtree Resources Ltd. of Bathurst in 1988. The company intends to continue operations pending market demand.

A second silica operation commenced production near Sussex in 1986. The Sussex Silica Inc. deposit is located about 22 km southwest of Sussex in the Cassidy Lake area. The source of material is a deposit of unconsolidated quartzose sand and gravel. Material is extracted from an open pit, washed and screened.

Much of the Sussex Silica's production is marketed as a lump silica product and used in the manufacture of silicon metal and silcon carbide. Various size fractions ranging from very coarse (150 mm) to fine (100 mesh) are capable of being produced. Some of the fine material from the sizing process contains a considerable percentage of kaolin clay.

Capacity of the Sussex Silica operation is estimated to be about 80 000 tonnes per year. There is potential for expansion of the operation should market demand warrant.

5.20 SULPHUR

Sulphur is one of the few elements which can be found in nature in an uncombined or pure state. However, it is much more common in a combined form, for example, in gypsum ($CaSO_4.2H_2O$), in hydrogen sulfide gas (H_2S) or in metal sulfides (pyrites).

Sulphur is an abundant mineral and is used in large quantities for a wide range of applications. Unlike most industrial minerals, sulphur is usually not used as a component of materials but rather as a reagent in material production with the sulphur being generally retained in the waste products. An example is the production of phosphatic fertilizers from phosphate rock where sulphuric acid is used in the process and yet becomes part of a gypsiferous waste by-product (see Phosphate Rock).

In Canada, a majority of the sulphur consumed is used in the reagent form of sulphuric acid (H_2SO_4). Sulphuric acid is one the most popular mineral acids used industrially relative to other acids. Of the 15 major uses of sulphuric acid the most significant are in phosphate fertilizer manufacture, in the pulp and paper industry, in the processing of uranuim ore, and in petroleum refining. In fact the fertilizer industry as a whole is the largest single user of sulphuric acid in the world.

Sulphur is recovered as a secondary product from two operations in the Province: the Brunswick Mining and Smelting Corporation Limited (Smelting Division) at Belledune, in northern New Brunswick and at the Irving Oil Limited refinery in Saint John.

Production of sulphuric acid at the Belledune smelter began in 1967. The smelting process results in the production of sulphur dioxide gas (SO_2). Environmental regulations limit the release of this gas into the atmosphere. The sulphur dioxide gas is cleaned of particulate matter using an electrostratic precipitator. The gas is then cooled and oxidized to sulphur trioxide (SO_3). Sulphur trioxide is made to react with a stream of sulphuric acid to from pryosulphuric acid ($H_2SO_4\ SO_3$) which is then reacted with water to form sulphuric acid. The resultant acid in the order of 94 percent strength is transferred to an adjacent fertilizer plant where it is used to produce diammonium phosphate, an important ingredient in blending fertilizers. Sulphur production from smelter gas in the Province has consistently exceeded 80,000 tonnes per year since 1981.

Sulphur is also recovered from crude oil during the refining process at the Irving Oil Limited refinery in Saint John. Sulphur content varies depending on the source region of the crude. A hydrogeneration process is used to convert organic sulphur compounds in the crude to hydrogen sulphide (H_2S). Up until the early 1970s, this gas was simply combusted as part of the fuel used by the refining process itself. In recent years, more stringent environmental regulations on sulphur emissions have reduced this practice. The hydrogen sulphide is now converted to sulphur. The H_2S is burned under controlled conditions so that about one-third is converted to sulphur dioxide (SO_2). The remaining H_2S and the SO_2 react in the presence of a catalyst to produce sulphur and water. Over 90 percent of the sulphur is removed by this process. The sulphur leaves the reaction vessel in a liquid (molten) form. While it can be shipped in this form, it is common practice to pour the sulphur into mold where it is allowed to solidify. In this dry state it can be stored indefinitely.

The Irving Oil Limited refinery produces in the order of 220 tonnes of sulphur per day which is marketed primarily to pulp mills in the Maritimes and northeastern United States.

5.21 TITANIUM

Titanium is a major component in approximately twenty minerals. Titanium minerals of consequence include anatase; TiO_2, ilmenite, $FeTiO_3$; perovskite, $CaTiO_3$; rutile, TiO_2; sphene, $CaTiSiO_5$ and leucoxene. Among the minerals of primary commercial interest are ilmenite, leucoxene, rutile and anatase.

Production of titanium has historically centered around three deposit types: beach and stream placers, primary deposits consisting of massive titaniferous iron ores, and igneous complexes in which rutile is found in association with anorthosites and similar rocks.

Although titanium is a metal it is often classified as an industrial mineral, a consequence of its main end use in the form of titanium dioxide (TiO_2) which because of its whiteness, high refractive index and light scattering ability makes it technically superior as a white colour pigment used in a variety of products. As a metal titanium is noted for two outstanding properties; its high strength-to-weight ratio and its exceptional corrosion resistance.

The only company that mines titanium ore in Canada, produces it from an anorthosite-hosted are body of ilmenite located north of Havre St. Pierre, Quebec. The deposit yields ore containing 35% TiO_2 and 40% Fe.

The largest market for titanium dioxide pigment is in surface coatings where it imparts whiteness, opacity and brightness to paints. Its high refractive index also makes it suitable for use in varnishes and lacquers.

The second largest market for titanium pigment is in paper coatings or as paper fillers to improve opacity, brightness, and printability. Titanium dioxide is used in photographic papers, in paper boxes requiring a light-coloured, high-gloss coating, and in practically all printing paper except newsprint.

The plastics industry, is the third largest market. Titanium dioxide's, resistance to degradation by ultraviolet light, its high refractive index, its whiteness, and its chemical inertness find wide application in many products made of polyethylene, polyvinyl chloride (PVC), polystyrene, and polyolefin-type plastics.

Occurrences of titanium dioxide in New Brunswick have been documented at a few locations. Two occurrences southeast of the city of Moncton have been superficially explored and may be regarded as warranting additional evaluation.

Near Taylor Village, anatase in Mississippian-age conglomerate has been reported. The mineralization, attributed to the alteration of pre-existing ilmenite or titaniferous magnetite, occurs as fragments or pebbles within conglomerates, believed to have been derived from a nearby source area. Preliminary investigations indicate the conglomerates contain between 2 to 20% anatase-hematite pebbles, which yield between 50-60% TiO_2 and 28-40% Fe_2O_3.

Two titanium bearing gabbroic rock units lying beneath 100 to 125 metres of Carboniferous age sediments have been intersected in drill holes, near Coverdale, south of Moncton. The most common unit is a fresh, coarsely crystalline, light-grey anorthositic gabbro containing accessory ilmenite-magnetite oxides concentrated along fractures in feldspar crystals. The second unit is an altered, soft, coarsely crystalline, dark green, amphibolitic rock with disseminated accessory ilmenite and magnetite. Drill core analyses from the area indicate a TiO_2 content in the order of 56.9% and an Fe content of 13.4%.

The Taylor Village anatase occurrence offers reasonable potential for successful titanium exploration. Its value lies as much in its usefulness as an exploration model as in the development potential of the actual occurrence. The prospects for similar mineralization in the region are considered to be good. The exploration model becomes more tenable when the Coverdale titanium occurrence is taken into consideration. This occurrence, documents the existence of ilmenite-rich rocks within one of the source areas for sediments of the Taylor Village-type titanium occurrence.

The potential of paleoplacers in other Carboniferous (Pennsylvanian) sediments throughout New Brunswick is unknown, however, these rocks are known to host abundant fluvial deposits, in some cases derived from heavy mineral-bearing source rocks.

6.0 INDUSTRIAL MINERAL RESOURCE MANAGEMENT

In New Brunswick, a statutory distinction is made between minerals and surficial materials such as sand, gravel, ordinary stone, building or construction stone, and peat. Consequently, the right to extract the respective materials is governed by two separate statutes: the Mining Act and the Quarriable Substances Act.

Both the Mining Act and Quarriable Substances Act are administered by the Department of Natural Resources and Energy.

Minerals

All minerals in about 97% of the Province are owned by the Province. In the remainder of the Province, landowners retain mineral rights obtained through the original "king's land grants." Exclusive rights to explore, develop, and produce from privately owned lands and those lands managed by the Crown are

gained under the conditions determined by the Province's Mining Act (and regulations) depending upon whether the material fits the definition of "mineral" as stated in the Act. The Act defines "mineral" as any natural, solid, inorganic or fossilized organic substance and such other substances as are prescribed by regulation to be minerals, but does not include:

(a) sand, gravel, clay, or soil unless it is to be used for its chemical or special physical properties, or both, or where it is taken for contained minerals.
(b) ordinary stone used for building or construction,
(c) peat or peat moss,
(d) bituminous shale, oil shale, albertite, or intimately associated substances or products derived therefrom,
(e) oil or natural gas, or
(f) such other substances as are prescribed by regulation not to be minerals.

Most rights under the Mining Act are obtained by staking mineral claims on lands open for staking; however, under certain curcumstances special agreements with the Province are arranged for large areas requiring temporary "protection" or for lands withdrawn from staking, prior to the establishment of mining leases (e.g., salt, potash and coal). A summary of mining rights under New Brunswick's Mining Act is presented in Table 1.

AGGREGATE AND PEAT

The ownership of aggregate and peat in New Brunswick is vested in the landowner who controls extraction, providing that legislation pertaining to the environment and employment safety standards are met.

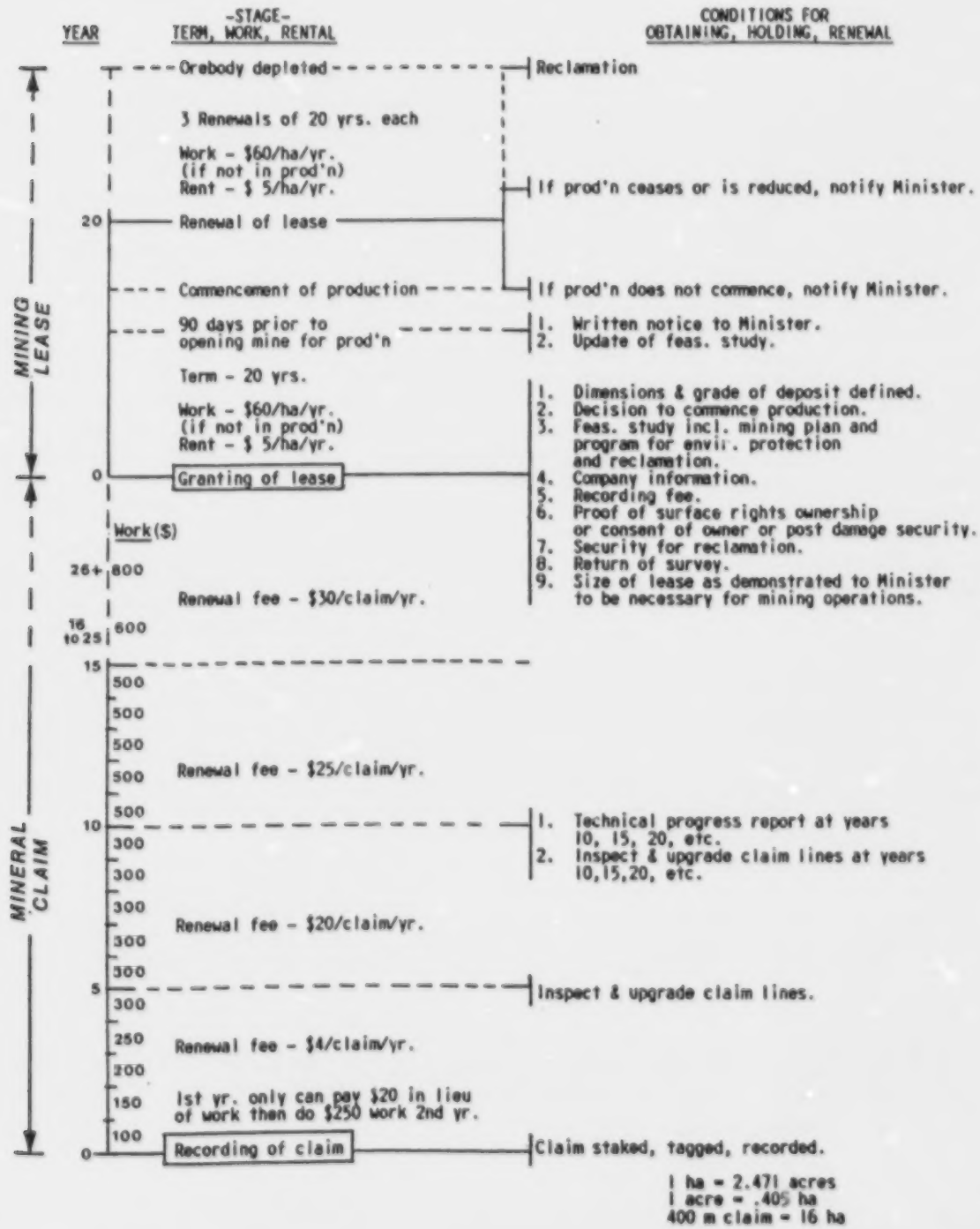
The private sector owns roughly 55% of the Province's land while the Crown in the right of the Province owns roughly 45%. Most of the source and market areas for aggregate are located in the areas where early settlers obtained land grants (eg., river valleys). Consequently, 80-85% of the sites producing sand, gravel, and crushed stone are located on privately owned land. In contrast, approximately 70% of the producing peatlands in the Province are owned by the Crown.

The Quarriable Substances Act (and regulation) applies to the extraction, under permit or lease, of quarriable substances from all Crown lands and designated shore areas that lie outside Crown lands. A quarriable substance is defined as: ordinary stone, building or construction stone, sand, gravel, peat moss, clay, and soil.

Under the Act, the Minister of Natural Resources and Energy may issue:

(a) a quarry permit covering an area on Crown land for a period of 12 months and a designated fee; or
(b) a quarry lease for a maximum of 21 years, but usually issued for 5 years subject to renewal.

TABLE 1.
The Mining Act of New Brunswick: Summary of Mining Rights.



A quarry lease grants the lessee exclusive use of land for the purpose of removing the stated material, whereas a quarry permit only grants permission for removal of the stated amount and does not grant exclusive use (i.e., more than one quarry permit can be issued on a pit provided conditions such as the size of the working face allow it). Both quarry permits and leases are subject to such terms and conditions as prescribed by the Minister. Applications for a quarry permit within a "shore area", i.e., within 300 m of the mean high tide mark, generally do not receive approval.

In New Brunswick, ownership of peat moss rests with the landowner. Because 70% (47,000 ha) of the peatland area having more than 1 m of peat is located on Crown lands, government has taken an active role in defining a management policy to control in development of this important resource. The objectives of the Crown Peat Resource Management Policy revised in 1988 are to maximize the contribution of the resource to the economic development of the Province and to encourage development in a manner that will not jeopardize future utilization or rehabilitation of the peatlands (see Open File Report 89-6).

A peat lease is required to quarry peat from Crown lands in New Brunswick. To obtain a peat lease, it is first necessary to acquire a peatland exploration licence. This licence reserves an area of up to 800 ha to allow the applicant sufficient time to ascertain that the quality and amount of peat in the proposed lease is suitable for the intended use. Providing that all requirements are met, the exploration licence is renewable annually to a maximum of three years. The issuance of a Peatland Exploration Licence is an extremely important step in obtaining a lease. It is granted only if the applicant:

(1) has no other licence in effect;
(2) can demonstrate that the proposed development will not adversely affect the future availability of peat for an existing leaseholder; and
(3) can market the product without jeopardizing the existing industry in the Province.

After determining the portion of the exploration area best suited for the proposed use, the applicant may then apply for a peat lease of 250 ha. The applicant must include a drainage plan, a mining and future expansion plan, and an abandonment and reclamation plan. If all requirements are met, a lease can be granted for a period of 10 years. Renewal for additional 10 year periods is possible if certain minimum production requirements and other conditions are met. A security deposit is required to ensure compliance with production and reclamation plans.

7.0 FUTURE TRENDS: INDUSTRIAL MINERAL PRODUCTION AND CONSUMPTION IN NEW BRUNSWICK

In the next decade and beyond, New Brunswick will be subjected to a number of major trends that could have a profound effect on its mineral industry. Weakening demands, intense competition from abroad, flucuating economic activity and increased substitution and recycling are all areas of concern.

From a global perspective it is possible to discern a definite trend for production of industrial minerals to grow faster than that of metals. The point when nonmetallic mineral commodities become more valuable than metals in a nations economy is widely variable but it has happened in nearly all mature industrialized countries. It happened in Great Britain in the 19th century, and in the United States during this century. In reality the gap between the total value of metals compared to that of industrial minerals produced in Canada, still favours metals by almost 2 to 1. This reflects on our nation's relative resource based economy as opposed to the manufacturing based economies of other nations.

The industrial minerals industry is fast gaining importance as a major contributor to the mineral industry of New Brunswick. The majority of our Province's production is designed for our own domestic market, although a few industrial mineral commodities such as potash and peat are exported abroad. As a result consumption of industrial minerals in the Province is highly sensitive to local economic conditions.

Relative to its small land mass, New Brunswick has a fairly diverse industrial mineral resource base. Some of the many occurrences and deposits not now being actively explored or developed have significant potential given a favourable economic climate. Improvements in mineral processing technology and the development of new applications, will play a significant role in the future demand for industrial mineral commodities both within the Province and abroad. A few examples of the future demands that may be placed on the Province's industrial mineral resource base are summarized:

Limestone

Limestone provides an interesting example of the effect emerging trends have on the consumption of industrial minerals within the Province. One particular area where there appears to be a potential for significant market growth for limestone and lime is in the field of environmental clean-up. The philosophy of controlling atmospheric sulphur dioxide emissions from coal burning utilities through various methods of flue gas desulphurization (FGD) offers an interesting and quite possibly a substantial market opportunity. Although there are several different technologies employed in FGD, they all have one thing in common - all utilize tremendous amounts of limestone.

Theoretically, the amount of pure limestone (100% $CaCO_3$) required to remove and fix 1 tonne of sulphur (SO_2), under ideal conditions, can never be less than 1.56 tonnes regardless of the FGD method employed. The potential

limestone requirement for SO_2 emission control in Atlantic Canada regardless of what method is used, can be illustrated using the following example. It has been estimated that current levels of SO_2 emissions from all sources in this part of Canada is around 480 000 tonnes per year. If these emission levels were to be reduced by 50 per cent, a minimum regional requirement of approximately 400 000 tonnes of limestone grading 95 percent $CaCO_3$, would be necessary. This theoretical estimate is probably low as operating experience with FGD systems currently in operation elsewhere in the world indicate actual limestone consumption would probably be 2 to 4 times the minimum tonnage requirement - probably more in the range to 800,000 to 1,600,000 tonnes per year since no FGD system can be expected to operate with 100% efficiency.

As our regional population levels increase, there will no doubt be increasing pressure for cost effective waste management. The utilization of lime and limestone, is still one of the cheapest and most effective means available.

As a mineral filler, fine ground or precipitated calcium carbonate (PCC) may experience accelerated growth. The largest volume growth potential is anticipated to occur in North American fine paper production with the plastics industry following as a close second.

New, improved agricultural practices also seem to assure continued growth for aglime.

As the need to find alternatives to high quality aggregates becomes increasingly necessary, the use of lime as a soil stabilizer is certain to gain some momentum.

The future of the cement industry in the Province is still very much in doubt faced with excess regional production capacity and shrinking traditional markets. Its rejuvenation will depend largely on the prosperity of the heavy construction industry and finding new market applications for cement products.

Potash

New Brunswick boasts two producing potash mines: one operated by the Potash Company of America (a Division of Rio Algom Limited) and the other by the Denison-Potacan Potash Company. Although BP Resources Canada Limited have signed a mining lease concerning a third potash property, the company has yet to make a production decision. Should an affirmative decision be forthcoming in the near future, it is conceivable a third mine could be established in the Province by the turn of the century.

At present, New Brunswick's annual potash production capacity of around 2 million tonnes KCl, relates to about a ten per cent share of total installed Canadian production capability.

Potash sales from New Brunswick have already made an impact on world supply. Apart from quantities sold to the highly competitive markets in eastern Canada and the United States, a significant proportion of New Brunswick output is sold outside of North America, particularly in South and Central America, Oceania and Europe. Ready access to cheaper ocean freight rates continue to give New Brunswick potash an important competitive edge over other North American producers in these market areas.

Most market observers project a rise in world potash demand at an average annual growth rate of between 1.5 and 3.5 per cent to the year 2000. At this rate, it is postulated that installed and planned Canadian production capacity could be totally utilized by mid-1990s requiring further expansion in the industry, a situation which could have very positive implications for New Brunswick.

Unstable market conditions which plagued the mid 1980s have no doubt played a significant part in delaying BP's decision to proceed in further evaluating and eventually bring their potash property into full production - a decision which could conceivably result in capital expenditures in excess of $400 million and expand the Province's annual productive capacity to 3 million (KCl) tonnes.

In addition to the three already confirmed potash deposits in the Sussex area, there remains some potential for those which remain as yet undiscovered. At least one area, situated in the extreme southeastern part of the Province, remains a possible candidate for a future potash-related exploration effort.

Graphite

The graphite market is experiencing growth in some of its principal applications. With only one producer of natural graphite in North America a significant portion of consumption is imported. World production is dominated by China and the Soviet Union. In 1987 the United States imported over 43,000 tonnes. A new source of supply from Atlantic Canada would no doubt be welcomed by most North American consumers and would realize a significant freight advantage over some current suppliers. Flake graphite, a higher priced material, represents one of the fastest growing market opportunities. The ability of New Brunswick to compete in this particular market would largely be a function of the relative merits of its graphite deposits which have yet to be thoroughly investigated.

Decorative and architectural stone (dimension stone)

New Brunswick has had a long history of building and decorative stone production reaching its peak around the turn of the century. At the present time stone quarried in the Province is represented by a relatively small number of quarries, generally operated on an intermittent or demand basis.

Interest in the application of natural building and decorative stone in new construction and restoration is experiencing a strong resurgence in North America. Dimension stone consumed by these industries, has a high unit value comparable to many precious minerals and base metal ores. The economic viability of an operation producing an attractive high quality product is probably less dependent on transportation than any other nonmetallic mineral commodity. New Brunswick is well located with respect to major North American stone markets.

The rejuvenation and the potential for an expanded domestic stone industry in the Province would appear to hinge on the promotion of stone which was quarried at one time and the identification of new stone resources of suitable structural integrity and aesthetic appeal.

Aggregate

The quantity and quality of the aggregate resource in New Brunswick varies considerably between regions. The eastern portion of the Province has limited resource potential whereas regions south of Bathurst and a large part of Charlotte County have extensive resources.

There are two major categories of aggregate materials: granular aggregate derived from surficial deposits of unconsolidated material and crushed stone derived from bedrock sources. Granular aggregate has a relatively low production cost since it typically can be extracted with a front end loader. However, the commodity has a relatively low unit value and as such is very sensitive to transportation costs. In regions where there are shortages of good quality granular material, demand must be met by quarrying and crushing suitable bedrock despite its higher production costs. In New Brunswick, crushed stone now accounts for almost 1/3 of all mineral aggregate production, supplying much of the coarse aggregate requirements for asphalt and concrete in the Fredericton, Saint John and Moncton areas.

With the possibility of several large aggregate consuming projects being undertaken in the region, an increasing potential for export, an increase in local consumption in response to regular maintenance projects and a demand for high specification material, it is likely that price and quality control will grow faster than aggregate production. High specification aggregate will become harder to find, harder to mine and more expensive. Since transportation is a major consideration in the cost of aggregate it is imperative that potential sources of high quality material be identified proximal to consuming centers and subsequently protected from conflicting land use.

8.0 EPILOGUE

Our way of life is dependent on a steady and adequate supply of industrial minerals which have become so essential to most manufactured products. It is a misconception that industrial minerals will always be readily available. All our mineral resources, including industrial minerals are not renewable. It is essential we use our mineral resources as wisely as possible.

The foregoing booklet is meant to provide a broad insight into the important role performed by industrial minerals in everyday life and in New Brunswick's mineral industry. Forming the foundation for so many basic products it is difficult to imagine how much different our lives would be without an adequate supply of these fundamental resources.

APPENDIX 1

MINERALS AND ENERGY STAFF

WHO CAN PROVIDE INFORMATION ON

INDUSTRIAL MINERAL RESOURCES AND DEVELOPMENT OPPORTUNITIES

IN NEW BRUNSWICK

Minerals and Energy Division Staff
who can Provide Information on
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in New Brunswick

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Tel.: 506-453-2206

Hugh John Flemming Forestry Centre

GEOSCIENCE PUBLICATIONS

APPENDIX 2

PRELIMINARY LISTING:

PRODUCERS OF INDUSTRIAL MINERAL PRODUCTS

IN NEW BRUNSWICK

PRELIMINARY LISTING: PRODUCERS OF INDUSTRIAL MINERAL PRODUCTS IN NEW BRUNSWICK

AGGREGATE

(See Figure B.1 for location and Open File Reports 88-19 and 88-20 for details)

Sand and Gravel

1. Avon Aggregates Limited
2.* MacDonald Paving & Construction Ltd.
3. Mollins Excavating Ltd.
4. Frizzell Bros. Construction Ltd.
5. A.H. Coates and Sons
6.* William J. Kerr Ltd.
7. Alex E. Flett Ltd.
8.* Northshore Construction Ltd.
9.* Newcastle Ready Mix Ltd.
10.* St. Isidore Ready Mix Ltd.
11. Raymond C. Doucet
12.* W.J. Kent & Co. Ltd.
13. Young and Buttimer Ltd.
14.* C.M. Stewart Co. Ltd.
15. Alford Bros. Construction Co. Ltd.
16.* Northern Construction and Supplies
17.* Gagnon Crushing & Aggregates Ltd.
18. Leonard Cook Construction Ltd.
19. Cummings Construction Ltd.
20. M.W. Price and Sons
21. Elmtree Concrete Ltd.
22. C.W. Guthrie and Son Ltd.
23.* Pine Grove Sand and Gravel Ltd.
24. Traycon Developments Ltd.
25. Rockland Construction Ltd.
26. Dunham's Contracting Ltd.
27. E & D Construction Ltd.
28. A. Law & Sons Ltd.
29. Warren Ready Mix Ltd.
30. Sandi Co. Ltd.
31. Ross A. Howe & Sons Ltd.
32.* Gorman Paving Inc.
33. Northside Ready Mix
34.* Warren Maritimes Limited
35. L.T. Harris & Son Ltd.
36. L.R. Moore
37. McNulty Cartage (1987) Ltd.
38.* Grove Construction (1986) Inc.
39.* D. Hatfield Ltd.
40.* Gulf Operators Ltd.
41. Fundy Bay Holdings Ltd.

NEW BRUNSWICK PRODUCERS

AGGREGATES

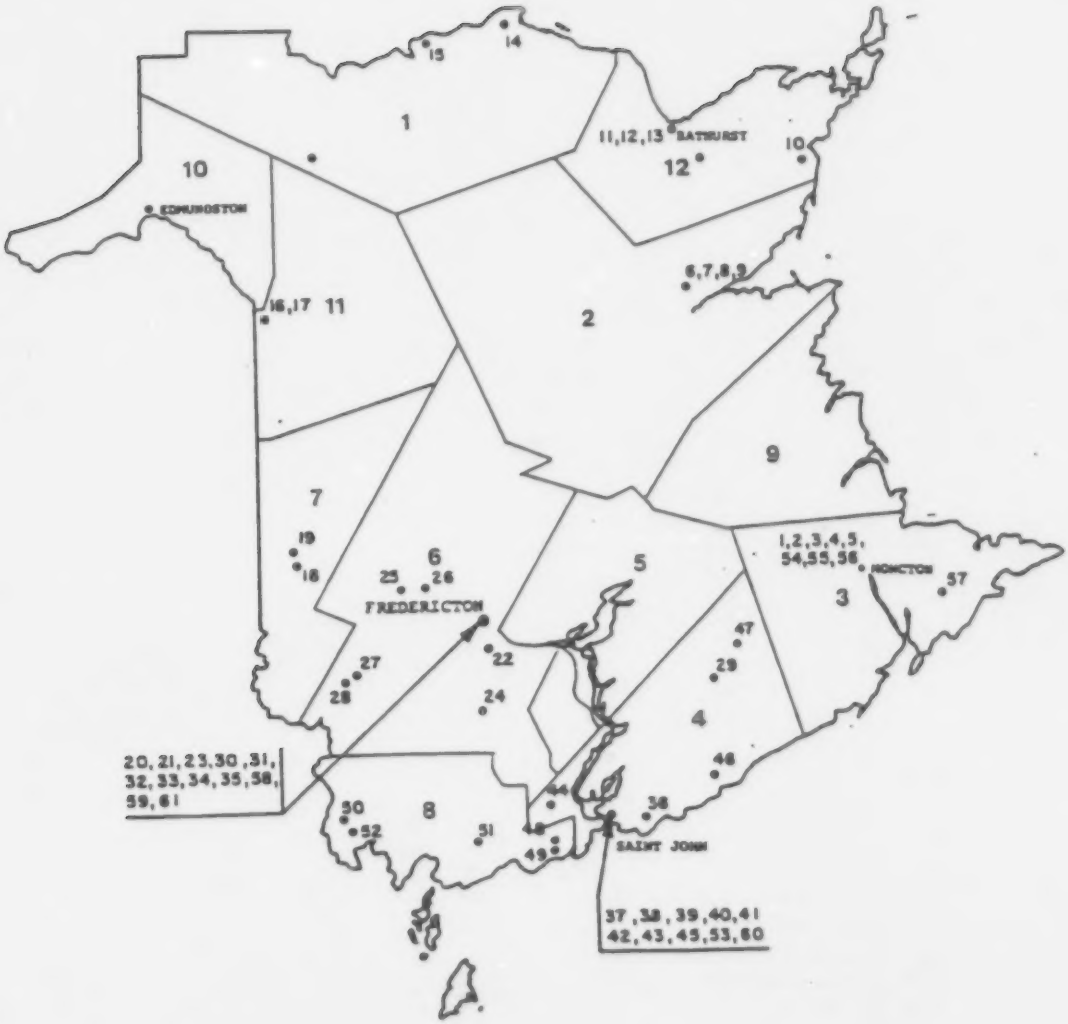

FIGURE B.1

NEW BRUNSWICK PRODUCERS

INDUSTRIAL MINERALS*

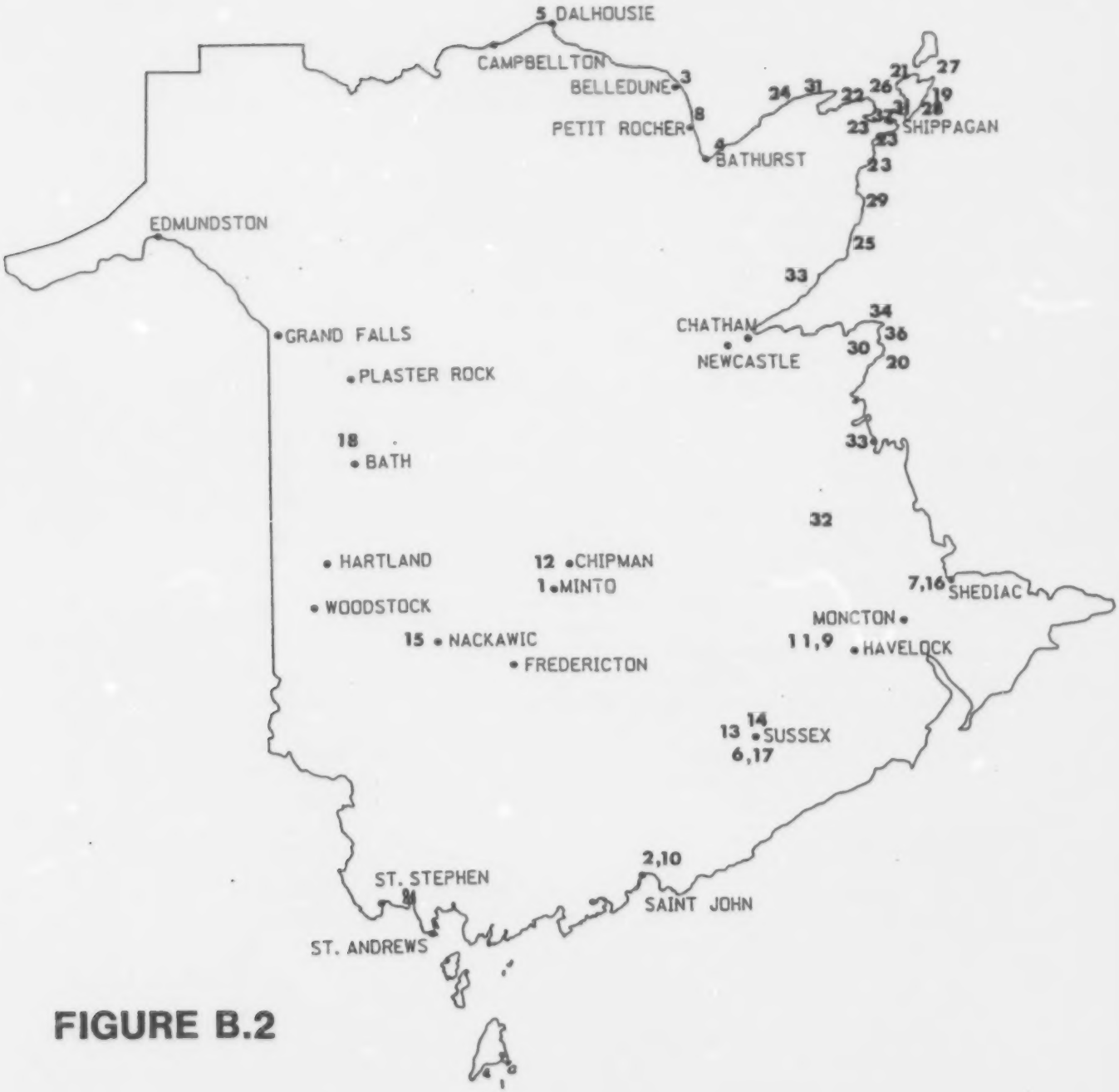

FIGURE B.2

*Other than aggregates

42. M.R. Carpenter Ltd.
43. Debly Construction Ltd.
44.* Charles E. Williams
45.* Thomas Construction
46.* Kathron Equipment Ltd.
47.* Chown Enterprises Ltd.

Crushed Stone

48. Keel Construction Ltd.
49.* Brunswick Ready Mix Concrete Ltd.
50.* Southwest Concrete and Construction Ltd.
51.* Fundy Contractors Limited
52. Devlin Construction Ltd.
53. F.A. Simpson Contracting Ltd.
54. Gray Stone Quarries
55. Carson Crushed Stone
56. Moncton Crushed Stone
57. Acadia Crushed Stone
58. Forbes and Sloat Inc.
59. Diamond Construction
40. Brookville Manufacturing Co.
41.* Valley Aggregates Ltd.

* Produce both Sand and Gravel, and Crushed Stone

CEMENT

(See Figure B.2 for location and Open File Report 89-40 for details)

Lafarge Canada Inc. (formerly Canada Cement Lafarge Ltd.) - inactive (11)

COMMON CLAY/BRICK SHALE/LIGHT WEIGHT AGGREGATE

(See Figure B.2 for location and Open File Report 89-40 for details)

Avon Aggregates Limited (1)
L.E. Shaw Limited (12)

DIMENSION STONE

(See Figure B.2 for location and Open File Report 89-40 for details)

Dupuis Cut Stone Ltd. (7)
Nelson Monuments Ltd. (13)
Smith Cut Stone and Quarries Limited (16)

GYPSUM

(See Figure B.2 for location and Open File Report 89-40 for details)

Lafarge Canada Inc. (formerly Canada Cement Lafarge Ltd.) - inactive (11)

LIMESTONE/DOLOMITE/MARL/LIME

(See Figure B.2 for location and Open File Report 89-40 for details)

Brookville Manufacturing Co. (2)
Elmtree Resources Ltd. (8)
Havelock Lime (a divison of Dickenson Mines Ltd. (9)
Lafarge Canada Inc. (formerly Canada Cement Lafarge Ltd.) - inactive (11)
Upper Kent Lime Works Ltd. (18)

PEAT MOSS

Acadian peat Moss (1975) Ltd. (19)
ASB Greenworld Ltd. (20)
Chiasson Peat Moss Ltd. (21)
Pokesudie Peat Moss Ltd. (22)
Fafard Peat Moss Co. Ltd. (23)
Grande-Anse Peat Moss Co. Ltd. (24)
Heveco Ltd. (25)
Lameque Peat Moss Ltd. (26)
Pigeon Hill Peat Moss Ltd. (27)
St. Raphale Peat Moss Ltd. (28)
Canadian Supreme Products Ltd. (29)
Theriault and Hachey Peat Moss Ltd. (30)
Fisons Western Corportion (31)
Kent Peat Moss Ltd. (32)
Burnt Church Peat Moss (33)
Good Earth Canada Ltd. (34)
Malpec Peat Moss Ltd. (35)
Berger Mix Inc. (36)
Jiffy Products (N.B.) Ltd. (37)

POTASH

Denison-Potacan Potash Company (6)
Potash Company of America (a division of Rio Algom Limited) (14)

SALT

Potash Company of America (a division of Rio Algom Limited) (14)

SILICA

Chaleur Silica Limited (see Elmtree Resources Ltd.) (4)
Sussex Silica Inc. (17)

SULPHUR

Brunswick Mining and Smelting Corp. Ltd.
Irving Oil Limited (Refining Division) (10)

INDUSTRIAL MINERAL-BASED CHEMICALS

CIL Inc. (5)
St. Anne Chemical Company Ltd. (15)

APPENDIX 3

PROVINCIALLY SPONSORED INDUSTRIAL MINERAL ACTIVITIES

1988/89

D.V. Venugopal and T.C. Webb

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PROVINCIALLY SPONSORED INDUSTRIAL MINERAL ACTIVITIES - 1988/89

Introduction

Industrial mineral related activities of the Minerals and Energy Division are carried out by the Nonmetallic Minerals Sector of the Mineral Development Branch. The sector is staffed by two geologists. Timothy (Tim) C. Webb, Industrial Minerals Geologist, serves as section head. In October 1988, the position of Nonmetallic Minerals Geologist was filled by D.V. Venugopal. This position resulted from a redistribution of responsibility within the Branch and in response to numerous inquiries and increased interest pertaining to the Province's industrial mineral resources.

In 1988-89, industrial mineral projects funded through the Division's regular annual budget and not the 1984-89 Canada-New Brunswick Mineral Development Agreement have included studies pertaining to graphite, limestone, and bedrock aggregate.

Graphite

Graphite has been known to occur in the Province of New Brunswick since the early nineteenth century. Small quantities were mined, used locally, and exported during the late nineteenth and early twentieth centuries.

A number of deposits are located within 50 km of the City of Saint John. Graphite occurrences in this part of the province can be grouped under two distinct geological associations. The first group is associated with the Precambrian rocks, while the second occurs in Late Devonian and/or Carboniferous strata.

The Precambrian localities from southwest to northeast comprise (Figure 1): 1) Gooseberry Cove; 2) Musquash Harbour; 3) Frenchmans Creek; 4) Mill Creek; 5) Lily Lake; and 6) Golden Grove. In general, graphite occurs as thin bands ranging in width from less than a metre to several metres. Strike lengths are variable. These bands display lensoid and en echelon patterns of distribution. The graphite is generally associated with limestone, marble, quartzite, and locally is found in calcareous argillite of the Green Head Group and/or Coldbrook Group. It is often localized along northeast trending faults and/or shear zones in the proximity of younger Precambrian granitoid intrusive rocks (i.e. the Golden Grove Granite).

There had been only cursory attention directed at graphite in the Province. However, an increase in demand for the commodity during the 1980's has led to renewed interest. This is particularly evident from the amount of exploratory work conducted on the Golden Grove graphite deposit, 25 km northeast of Saint John. In 1982, Glenvet Resources Ltd. conducted geological mapping, geophysical surveys, and trenching which led to the delineation of three north-northwesterly trending, steeply dipping graphite zones occurring in limestone and quartzite of the Golden Grove Group. It is believed that the graphite-bearing rocks occur as roof pendants within the Golden Grove intrusive suite.

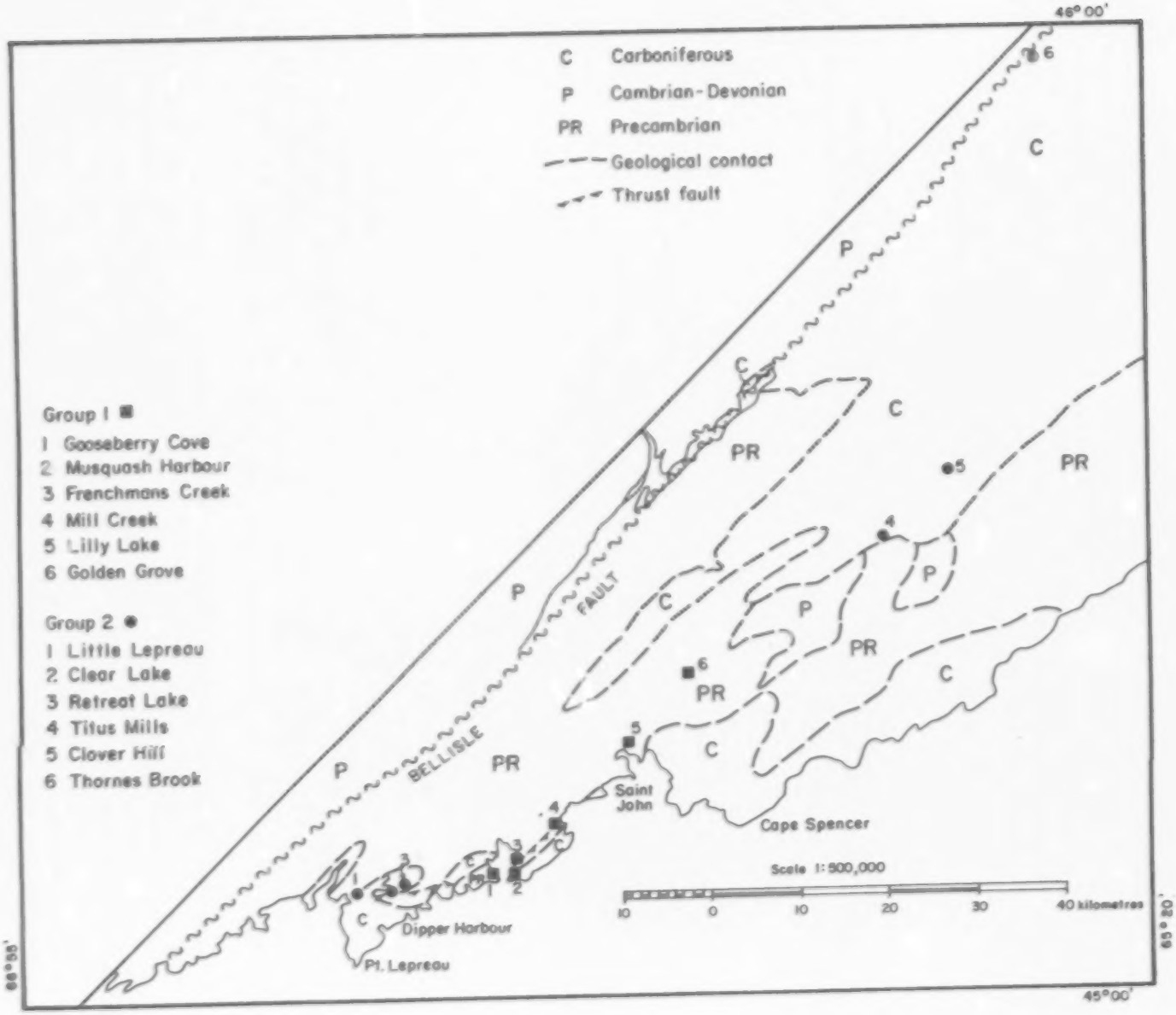

Fig. 1. Graphite localities in Southern New Brunswick.

A total of 22 diamond-drill holes totalling about 2960 m have been put down over a strike length of 350 m. Trenching and drilling indicate an estimate of total reserves in excess of 20,000 tons of 22.37% graphitic carbon (using 10% graphitic carbon cut off) to a mineable depth of 130 m. Mineralogical and metallurgical tests indicate that the graphite is probably a potential source of flake graphite.

Other graphite occurrences in Precambrian strata throughout the region require more work to determine their extent and the quality of the graphite mineralization.

Graphite associated with Late Devonian and/or Carboniferous age rocks include (Figure 1): 1) Little Lepreau; 2) Clear Lake (also referred to as Dipper Harbour graphite); 3) Retreat Lake; 4) Titus Mills; 5) Clover Hill; and 6) Thornes Brook. At these localities, graphite occurs primarily in clastic sedimentary rocks, often associated with coal-bearing horizons.

In 1953, Copper Cliff Consolidated Mining Corporation conducted geological and geophysical surveys exploring for graphite in the Clear Lake area about 3 km north of Dipper Harbour. Through these surveys, the company identified an electromagnetic conductor nearly coincident with a magnetic anomaly, about 3 km due south of Clear Lake.

The area is underlain by a sequence of rocks that comprise sandstone, slate, and conglomerate of the Lancaster Formation. These, in turn are unconformably underlain by predominantly felsic volcanic rocks intercalated with minor slate of possible Eocambrian age. Small pods of granitoid rocks of unknown age occur in the vicinity. The conductor was drilled to a depth of about 76 m. At a depth of approximately 40 m, a 7 m band of graphite, averaging 11% graphitic carbon, was intersected.

Approximately 1 km northeast of Retreat Lake, graphitic material occurs near an old mine shaft and related pits. These were the workings of the Musquash Anthracite Company, which investigated the property in the late nineteenth century for coal. As at Clear Lake, carbonaceous graphitic material occurs in the clastic sedimentary rocks of the Lancaster Formation. During the late 1940's, three exploratory drillholes were put down by the provincial Department of Lands and Mines to confirm the presence of coal in the area. The project was soon abandoned due to failure to identify a suitable deposits.

Recently (1988), a grab sample of the carbonaceous graphitic material was analyzed by Gordell Investments Ltd. and yielded 38.5% graphitic carbon. As a follow-up, an electro-magnetic survey identified an east-north- easterly trending conductor. Due to thick overburden, trenching has not yet revealed the presence of graphite. Reconnaissance mapping has indicated the presence of carbonaceous graphitic material along Highway 790, about 1.2 km northeast of the old mine shaft.

Graphite in the Clear Lake and Retreat Lake areas appear to be related to a fault zone between Carboniferous clastic rocks and a felsic volcanic and sedimentary sequence of Eocambrian age. Graphitic material associated with highly carbonaceous strata at other occurrences in the region probably merit further investigation.

Limestone:

It is becoming increasingly important to sufficiently identify Provincial limestone deposits with respect to quality, apparent reserves, and factors affecting potential development in order to confront the anticipated rigid market requirements of the future. As a move in this direction, the New Brunswick Department of Natural Resources and Energy is currently re-examining and reassessing the Province's limestone resources. The project consists of five main phases that address such topics as historical development and current status of the limestone industry, and practical geologic aspects of known deposits and occurrences. A number of important deposit characteristics (grade ranges, reserves, development potential, etc.) are to be combined into a computerized information retrieval system for quick reference.

The present status and related outputs of this project are summarized in the paragraph that follows and Figure 2.

The 1988-89 outputs of the limestone resource inventory project consist of: a) draft report and accompanying 1:10 000 scale maps concerning various aspects of Silurian and Ordovician limestone deposits in the Province; b) computerized sample inventory; c) preparation of a deposit classification and rating scheme for Silurian and Ordovician limestones as an indication for future development potential.

Bedrock aggregate resource potential in parts of NTS 21 G, H, J, and P map areas:

Dwindling reserves of granular aggregate, high transportation costs, tighter environmental regulations, and higher construction specification standards are among some of the factors affecting consideration of utilizing high quality bedrock aggregate, despite its higher cost of production. Demand for the bedrock aggregate in New Brunswick has been steadily increasing over the last decade.

A lack of province-wide information pertaining to bedrock aggregate resources has been identified during the last few years. This has prompted the Mineral Development Branch to initiate a program dealing with the establishment of a data base pertaining to potential bedrock aggregate resources throughout New Brunswick. In 1988, a pilot project was carried out which included the preliminary regional evaluation of bedrock aggregate in selected parts of the Province. This project was completed during the summer of 1989 and a report of investigation was submitted. This is currently being finalized as a report for public use.

The project was designed to "reference" and identify potential sources of bedrock aggregate in two selected map areas: 1) Caledonian Uplands - extending southwest of Moncton to the Saint John area; and 2) an area northwest of Fredericton (Figure 3). The selection of these areas was primarily based on projected high demand and high density activity requiring good quality aggregate material.

Included in the study was a historical analysis of production and consumption statistics and identification of rock types favourably located as

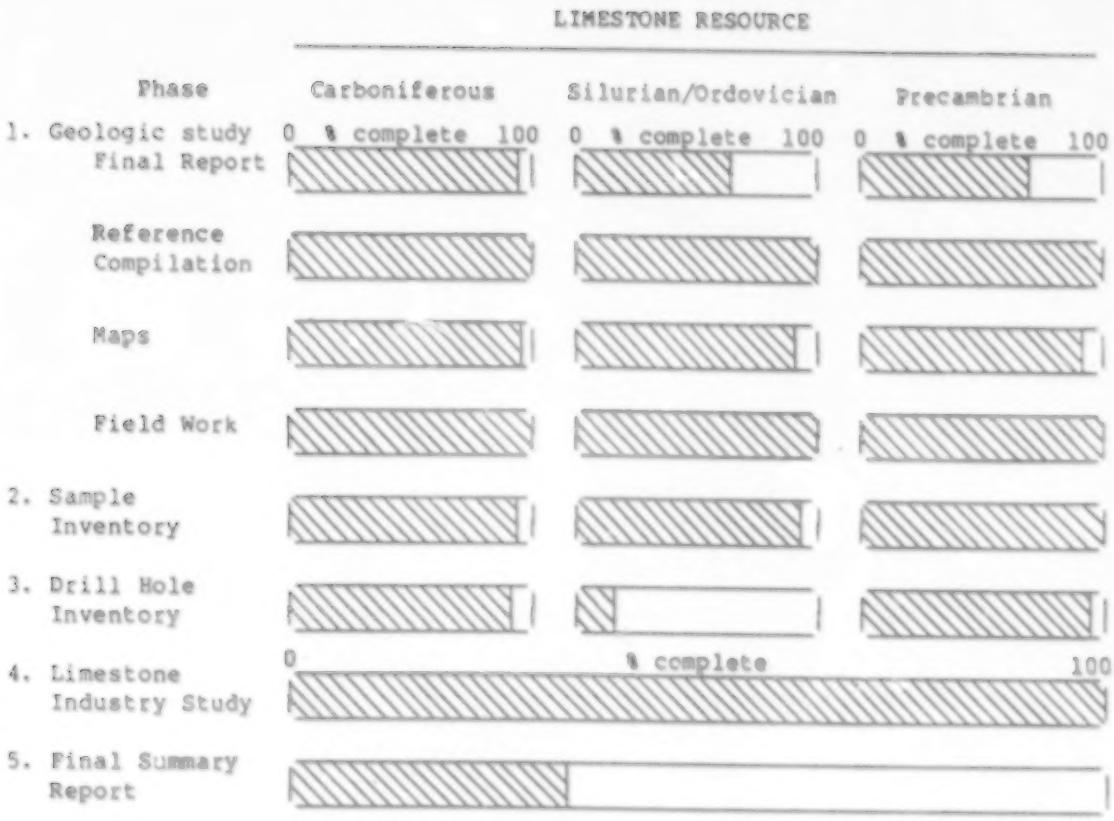

Fig. 2. Status of the limestone resoure inventory project in 1988.

BEDROCK AGGREGATE PROJECT

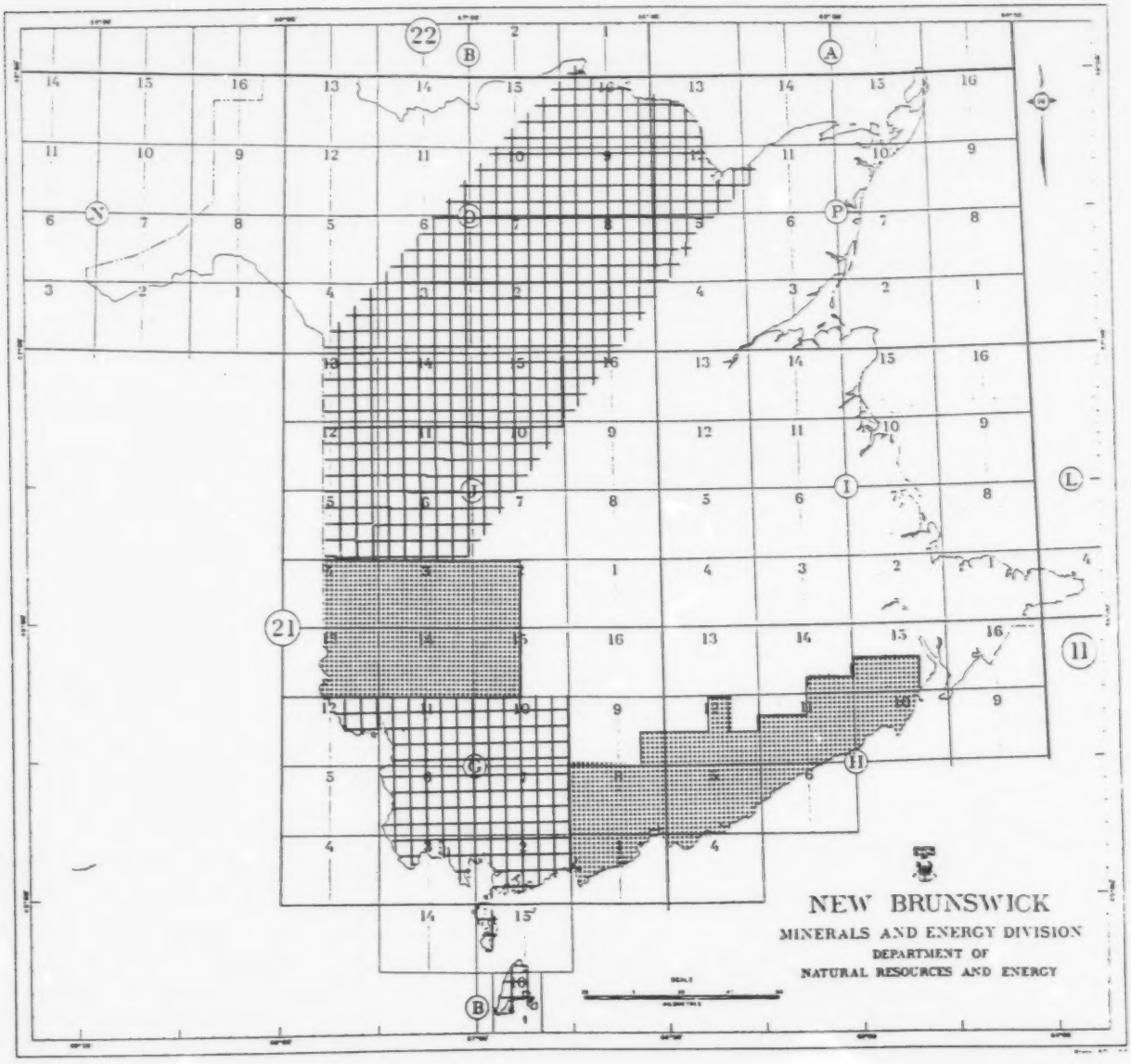

Figure 3

Area under M.D.A. program

Area under Provincial program

sources of high specification aggregate. The purpose of this initial evaluation was to provide basic information on selected rock types pertaining to several engineering specifications (quality) for user industries rather than to actually locate potential quarry sites.

The investigation included selection and sampling of some 80 sites. The samples were subjected to specific engineering tests in order to establish evaluation criteria in identifying potential sources of high quality material. Although this initial attempt may have certain shortcomings, it does serve as a general data base framework for the purpose of a regional resource inventory.

During the summer of 1989, the persistent increase in demand from consumers for high quality aggregate led the Mineral Development Branch to undertake a sampling program in the three additional areas of the province (Figure 3). Engineering tests will be carried out on these samples and the processed data will be incorporated into the data base for future consumer use, pending allocation of necessary funds.

It is hoped that the bedrock aggregate inventory can eventually be extended to most parts of the province.

The writers are grateful to L.R. Fyffe, of the Department's Geological Surveys Branch, for discussions in the field with regard to graphite investigation.

APPENDIX 4

INDUSTRIAL MINERAL INVESTIGATIONS

AND THE

1984-89 CANADA-NEW BRUNSWICK

MINERAL DEVELOPMENT AGREEMENT

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INDUSTRIAL MINERAL INVESTIGATIONS AND THE 1984-89 CANADA - NEW BRUNSWICK MINERAL DEVELOPMENT AGREEMENT

Introduction

As part of the 1984-89 Canada-New Brunswick Mineral Development Agreement (M.D.A), the New Brunswick Department of Natural Resources and Energy, and Energy, Mines and Resources Canada have initiated several industrial mineral programs designed to stimulate mineral development in New Brunswick. These programs include commodity market studies, mining and mineral technology programs, resource evaluation and inventory projects, and public awareness projects.

Industrial mineral investigations to date, have been carried out under four programs delivered through the MDA: Economic Development (32 projects) Mining and Minerals Technology (5 projects), Public Awareness (1 project), and the Mineral Investment Stimulation Program (3 projects). The design and terms of reference for most projects has generally been a cooperative effort between the New Brunswick Department of Natural Resources and Energy (D.N.R.E.), Energy, Mines and Resources, Canada (E.M.R.) and the Province's mineral industry. The following is a brief summary of those projects completed or in progress under each program of the current Agreement:

I. ECONOMIC DEVELOPMENT PROGRAM

1. Project: A Study on Potassium Sulphate Technology and North American Marketing

   Type: Commodity Study

   Year(s): 1984-85

   Lead Agency: D.N.R.E.

   Description: Existing and new technologies for the manufacture of potassium sulphate were reviewed

   The international and local supply/demand situation for potassium sulphate were reviewed.

   Output: Open File Report 88-6

   Funding: Provincial M.D.A.

2. Project: The Limestone Industry in New Brunswick

   Type: Commodity Study

   Year(s): 1985-86

Lead Agency: D.N.R.E.

Description: This study provided detailed, contemporary information concerning the state of the limestone industry in New Brunswick including an assessment of the current supply/demand situation in the Province and adjacent areas along with future development opportunities.

Output: Open File Reports 87-6 and 87-7

Funding: Provincial M.D.A.

3. Project: Study of Markets for Aggregate Materials Accessible from Nova Scotia and New Brunswick

Type: Commodity study

Year(s) 1985-86

Lead Agency: E.M.R. (Mineral Policy Sector)

Description: This project identified markets for mineral aggregates external to Nova Scotia and New Brunswick and determined specifications, costs, delivery patterns, current sourcing, etc.

Output: Open File Output 86-9

Funding: Jointly funded from Federal M.D.A. of New Brunswick and Nova Scotia

4. Project(s): A Granular Aggregate Resources of the Big Bald Mountain (N.T.S. 210/1), Serpentine Lake (N.T.S. 210/2), and California Lake (N.T.S. 210/8), New Brunswick.
B Granular Aggregate Resources of the Kedgwick, Saint-Quentin, Grand River area (N.T.S. 21N/16, 210/5, 11, 12, 13, 14) Northeastern New Brunswick.

Type: Resource Management Strategies

Year(s): 1985-86

Lead Agency: D.N.R.E.

Description: Aggregate resources on N.T.S. Map Sheets 210/1, 2, 5, 8, 11, 12, 13, 14 and 21N/16 were mapped.

Output: Open File Reports A. 86-4 and B. 86-5

Funding: Provincial - M.D.A.

5. Project: Economic Evaluation of Potassium Sulphate

Type: Resource Management Strategies

Year(s) 1985-89

Lead Agency: D.N.R.E.

Description: An economic analysis of the production of potassium sulphates using indiginous salt and potash was conducted.

Possible new technology for potassium sulphate production is under investigation.

Industry is being approached to participate in a pilot facility for potassium sulphate manufacture.

Output: In progress

Funding: Provincial M.D.A.

6. Project: Market Analysis for New Brunswick, Nova Scotia, and Newfoundland Dimension Stone

Type: Commodity Study

Year(s): 1985

Lead Agency: E.M.R. (Mineral Policy Sector)

Description: Markets for building stone within reasonable access of deposits in Nova Scotia, New Brunswick and Newfoundland were studied.

Outputs: Open File Report 87-10

Funding: Study was jointly funded from Federal M.D.A.'s of New Brunswick, Newfoundland and Nova Scotia.

7. Project: Opportunities for Specialty Silicas

Program: Economic Development

Type: Commodity Study

Year(s): 1987

Lead Agency: E.M.R. (Mineral Policy Sector)

Description: A comprehensive report listing major consumers of specialty silicas, specifications by use, suppliers, competition and forecasts of supply-demand was purchased.

Outputs: "Opportunities for Specialty Silica" from Charles H. Kline & Co. Inc. (not available for distribution)

Funding: Purchase was jointly funded from Federal M.D.A.'s of Newfoundland, New Brunswick, and Nova Scotia

8. Project: Industrial Minerals Used in Oil and Gas Exploration on the Eastern Canadian Offshore

Type: Commodity Study

Year(s): 1985

Lead Agency: E.M.R. (Mineral Policy Sector)

Description: The utilization and consumption of industrial minerals by the offshore oil and gas industry, with particular reference to companies operating off Canada's east coast was determined. The study also included specific corporate linkages between major oil and gas exploration companies working offshore of Canada's east coast and companies providing industrial minerals to these operations.

Outputs: Open File Report 86-6

Funding: Study was jointly funded from Federal M.D.A.'s of New Brunswick, Nova Scotia and Newfoundland.

9. Project: Study of the Non-Metallurgical Markets for Manganese Ore

Type: Commodity Study

Year(s): 1986

Lead Agency: E.M.R. (Mineral Policy Sector)

Description: The supply/demand balances for manganese research studies were conducted to determine present and forecast markets, for domestic and world production and trade to the year 2000 for manganese ore, battery grade manganese dioxide and manganese metal. A secondary objective involved the identification of business opportunities for the marketing of Woodstock manganese ore.

Outputs: Open File Report 87-9

Funding: Federal M.D.A.

10. Project: A Study of U.S. East Coast Industrial Mineral Markets for New Brunswick, Newfoundland and Nova Scotia.

Type: Commodity Study

Year(s): 1986-88

Lead Agency: E.M.R. (Mineral Policy Sector)

Description: A study of markets for fifteen (15) major industrial minerals within a corridor along the United States East and Gulf Coasts was commissioned. The 15 commodities were designated by New Brunswick, Nova Scotia and Newfoundland and represented existing or possible producing deposits in these provinces.

Outputs: Open File 88-15.

Funding: Study was jointly funded by Federal M.D.A's of New Brunswick, Nova Scotia and Newfoundland.

11. Project: Peat Moss Market Study

Type: Commodity Study.

Year(s): 1986-88

Lead Agency: D.N.R.E.

Description: The historical, present and future supply/demand for peat moss in New Brunswick and North America were reviewed.

Market opportunities in the offshore for New Brunswick's high quality sphagnum peat were reviewed.

Traditional uses, identification of possible new and emerging applications of peat moss and a compilation of details pertaining to physical and chemical specifications of these applications together with testing procedures were also reviewed.

Output: Open File Report 87-16

Funding: Provincial M.D.A.

12. Project: Atlas of Granular Aggregate Resources - New Brunswick

Type: Resource Management Strategies
(Provincial Aggregate Inventory)

Year(s): 1986

Lead Agency: D.N.R.E.

Description: This atlas is a simplication and summary of the detailed

1:50,000 scale maps produced the course of a province-wide granular aggregate inventory program. Its purpose is to provide industry, planners, and others dealing regularly with aggregate resources, with ready access to information on the regional distribution of the granular aggregate resources in New Brunswick.

Output: Miscellaneous Report # 6

Funding: Provincial M.D.A.

13. Project: Survey of the Uses of Peat in Agriculture

Type: Resource Management Strategies (Peat Technology)

Year(s): 1986

Lead Agency: D.N.R.E.

Description: A literature search on new technologies for peat usage was carried out. The use of compressed peat as the filler component in blended fertilizers, i.e. substitution for limestone for use in areas where soils lack organic matter was investigated.

The preparation of peat moss and fertilizers by blending, compressing and crushing to produce high organic fertilizers was investigated.

In conjunction with Dept. of Agriculture the usage of high organic content fertilizers was tested by field application.

Output: Open File 87-8

Funding: Provincial M.D.A.

14. Project: Reclamation Options for Abandoned Commercial Peatland

Type: Resource Management Strategies
(Peat Technology)

Year(s): 1987

Lead Agency: D.N.R.E.

Description: Peatland reclamation options were reviewed in order to establish the information base necessary to develop provincial guidelines for the reclamation of abandoned production bogs located on Crown Lands.

Output: Open File Report 88-7

Funding: Provincial M.D.A.

15. Project: Industrial Mineral Production and Consumption in New Brunswick

Type: Commodity Study

Year(s): 1987-89

Lead Agency: D.N.R.E.

Description: The purpose of the study was to provide information concerning the state of the industrial minerals industry in New Brunswick from both a producer's and consumer's point of view.

Although the study focused primarily on the supply and demand of industrial minerals and industrial mineral-based chemicals produced and consumed in the province, the demand for similar products in market areas considered reasonably accessible to a local producer were also evaluated to some extent.

The results of the review, issued in the spring of 1989, consist of a six-volume report. Volumes 1, 2, and 3 detail the history of specific industrial mineral production and consumption in New Brunswick and current demand within a market place easily accessible from the Province. Volume 4 provides demand projections for key industrial minerals, and describes the possible effects on future demand from environmental, technical, and other developments. Finally, Volumes 5 and 6 include a directory of New Brunswick's industrial mineral producers and consumers of industrial minerals within economic shipping distance of New Brunswick.

Output: Open File Report 89-36, Volume 1 - Industrial Minerals Used Primarily in the Fertilizer Industry

Open File Report 89-37, Volume 2 - Industrial Minerals Used Primarily in the Construction Industry

Open File Report 89-38, Volume 3 - Industrial Minerals Used Primarily in the Chemical and Pulp and Paper Industries

Open File Report 89-39, Volume 4 - The Future of Industrial Minerals: General Trends in Consumption and Transportation

Open File Report 89-40, Volume 5 - Directory of New Brunswick Industrial Mineral Producers

Open File Report 89-41, Volume 6 - Directory of Consumers of Industrial Minerals in Eastern Canada and Northeastern United States

Funding: Provincial M.D.A.

16. Project: Potash Market Review

Type: Commodity Study

Year(s): 1987

Lead Agency: D.N.R.E.

Description: Since the early 1980's, the once stable world potash industry has been hit by a series of setbacks that have threatened to disrupt the entire structure of the industry. Forecasts by most analysts predict a continuing massive surplus of potash supply well into the 1990's.

Against this background, British Sulphur, a leading specialist business consultant, and publisher to the fertilizer and related mineral and chemical industries, undertook a multi-client study, re-evaluating the world potash industry.

In view of the various factors affecting world potash market conditions, it is important to have access to the best information available, in order to determine the future direction of potash development in New Brunswick.

British Sulphur developed a study entitled "Potash - A Market in Transition." The report which consisted of two main parts; a historical section and a forecast section completed in July, 1988, and is to be made available through a special subscription offer.

The study focused on developments in the potash market to the mid - 1990's. Key developments in the industry since the early 1980's were intensively assessed for their implications for the future. Such a study is considered essential in formulating the future direction of potash development in New Brunswick.

Output: Report entitled "Potash - A Market in Transition" (not available for distribution)

Funding: Provincial M.D.A.

17. Project: Rock Mechanics Program for Cut and Fill Potash Mining

Type: Resource Management Strategies

Year(s): 1987-89

Lead Agency: D.N.R.E.

Description: To ensure the overall stability in potash mine.

To minimize and understand local ground control problems in the slopes and entry ways.

To maximize safety - both to people and the resource.

Optimize extraction of the ore to increase productivity and operational efficiency.

To improve measurement and analytical techniques.

To transfer the results, ideas and technology to the Canadian mining industry.

Output: Final report submitted

Funding: Provincial M.D.A.

18. Project: New Brunswick Dimension Stone Resources (Specimen Catalogue and Brochure)

Type: Commodity Study

Year(s): 1987-89

Lead Agency: E.M.R. (Mineral Policy Sector)

Description: In 1986, the current Federal-Provincial Mineral Development Agreement (Economic Development Program) sponsored a study to explore a broad range of issues related to the availability, application and market trends for building and ornamental stone products, considered relevant to Atlantic Canada.

During the course of this investigation, attempts were made to determine and quantify markets for various types of building stone within reasonable access of New Brunswick, Newfoundland and Nova Scotia. The study confirmed a definite trend towards an increase in the application of stone products in industrial, commercial and institutional construction, particularly in major business centres of eastern Canada and in the eastern United States.

Although the use of large, thin veneer granite panels appear to be among the most popular and widespread applications, it is anticipated that potential opportunities also exist for traditional stone products (natural stone blocks for cladding, foundation stone, curbing, etc.).

It would appear that an important avenue to pursue leading to a potential market expansion and development for Atlantic Canada stone is to effectively promote the increased use of our indigenous domestic resources both at home and abroad by informing key representative organizations and potential consumers as to the type of stone available. New Brunswick's most recent attempt at such a promotional campaign was centred around a colour brochure highlighting granite, published about ten years ago. These promotional brochures are now out-of-print and it became apparent that a fresh approach, once again addressing this important promotional aspect, was required. This should enable the Province to be in a position to take advantage of any potential opportunities concerning the development and competitiveness of this resource. Towards this goal, the production of a display package incorporating a wide range of individual stone samples appears to be an effective method of promotion. There is no substitute for an actual hand specimen of a stone product, when considering its use for a specific application.

The object of this project was to produce an effective promotional display package illustrating the wide variety of building stone resources available in New Brunswick. This initiative is intended to attract the interest of architectural firms and building contractors in identified market areas, as well as to promote development of our indigenous dimension stone resources.

Although this project primarily focused on attractive, relatively accessible granite and sandstone resources from abandoned quarries, a few rock types demonstrating some unique visual characteristic were also considered for their decorative applications.

Two main entities comprise this project:

- A catalogue of finished stone specimens;
- An independent colour brochure of stone specimens and related information.

Output: Miscellaneous Report No. 7 and 50 specimen catalogues.

Funding: Federal M.D.A.

19. Project: Assessment of New Brunswick Dimension Stone Resources.

Type: Resource Management Strategies

Year(s): 1988-89

Lead Agency: D.N.R.E.

Description: Various New Brunswick stone resources not previously developed or quarried, are to be assessed as potential sources of dimension stone. Priority is to be given to exposures of granite and red sandstone, preferably located on Crown Land within 1 - 2 kilometres of a road. An attempt is to be made to evaluate each site on the basis of ideal development characteristics (i.e. widely spaced vertical and horizontal joint sets; aesthetically appealing homogenius colour and homogeneous texture; unaltered mineral constituents, outcrops of high relief covering an extensive area (100 m^2); proximity to road or railway and absence of sulphide and oxide minerals).

Information on selected sites is to be compiled in a report which will highlight rock type, mineralogy, colour, texture, jointing pattern, nature of outcrop, access and location, map compilation and land ownership. A reference collection is to be assembled.

Discussion with the Province's two existing dimension stone producers has indicated a desire to have additional quarry sites identified. These companies lack geological staff and the resources to search for such sites. One operation has indicated the demand for red sandstone has increased dramatically in recent years but to date no suitable and accessible deposits have been located in the Province.

Such a project should significantly enhance the development of the province's stone resources through locating unique deposits capable of being developed by local operators.

Output: In progress (draft report submitted)

Funding: Provincial M.D.A.

20. Project: New Brunswick's Building and Decorative Stone Heritage.

Type: Commodity Study.

Year(s): 1988-90

Lead Agency: D.N.R.E.

Description: A qualified consulting firm is to undertake a study concerning the history of the dimension stone industry in New Brunswick. A prime objective is to consolidate archival information from various sources demonstrating the valuable contribution of stone to the early construction industry in the Province. Such an approach is viewed as an attempt to inform the public of the historical importance of this industry which now appears to be showing signs of revival throughout North America.

A detailed, well illustrated report is to be prepared addressing various historical aspects of the stone industry: its choice as a building material, where stone was quarried and by what methods, past markets for N.B. stone and major applications and history of past and present producers/fabricators. An intregal part of this study involves the preparation of a catalogue of major stone structures in the Province (buildings, bridges etc.). Included would be information such as year of construction, builders (contractor), architect, present ownership/use, stone type and original quarry source for most structures and an update on the condition and access to original quarry site.

This project should not only be of interest to tourists etc. but should also demonstrate to the public the relative importance and long term durability of stone as a basic building material for both decorative and foundation purposes. The catalogue should be an important reference guide to architects, contractors, masons etc. particularly those concerned with renovation and restoration of existing stone structures.

Output: In progress (65% complete)

Funding: Provincial M.D.A.

21. Project: Bedrock Aggregate Resource Potential of Selected Map Areas in New Brunswick.

Type: Commodity Study

Year: 1988-89

Lead Agency: D.N.R.E.

Description: The quantity and quality of the aggregate resource in New Brunswick varies considerably between regions. The eastern portion of the Province has limited resource potential whereas regions such as Bathurst and Charlotte County have extensive resources. There are two major categories of aggregate materials: granular aggregate derived from surficial deposits of unconsolidated material and crushed stone derived from bedrock. Granular aggregate has a relatively low production cost since it typically can be extracted with a front-end loader. However, the commodity has a relatively low unit value and as such is sensitive to transportation costs. In regions where there are shortages of good quality granular material, demand must be met by quarrying and crushing suitable bedrock material despite its higher production costs.

In New Brunswick, crushed stone accounts for a significant proportion of aggregate production, supplying much of the coarse aggregate requirements for asphalt and concrete in the Fredericton, Saint John and Moncton areas.

With the possibility of several large aggregate consuming mega projects in the region, an increasing export potential, an increase in local consumption and a demand for high specification material, it is likely that price and quality control will grow faster than aggregate production. High specification aggregate will be harder to find, harder to mine and more expensive. Since transportation is a major consideration in the cost of aggregate it is imperative that potential sources of high quality material be identified proximal to consuming centers and projects and subsequently protected.

The Department of Natural Resources and Energy has recently completed an extensive mapping program which assessed the quality and general distribution of granular aggregate resources in all regions of the Province. In the light of perceived increase in demand for high specification aggregate, the results of the granular aggregate resource inventory demonstrated that strategically located bedrock has the potential to become an increasingly more attractive source of aggregate material. This will be of particular importance to parts of the Province where the forecast demand for aggregate is high and an adequate supply of suitable granular material is low. It was therefore considered appropriate to initiate a program committed to the evaluation of areas with crushed stone potential and incorporate them into the existing province-wide aggregate resource inventory.

Output: Reference 174

Funding: Provincial M.D.A.

22. Project: Cement Market Review for New Brunswick.

Type: Commodity Study

Year: 1988-89

Lead Agency: D.N.R.E

Description: In 1987 New Brunswick's only cement manufacturing facility was closed indefinitely. Apparently shrinking markets for cement products in the region, had made it impossible to maintain a profitable operation. Subsequent to this decision, it is considered appropriate to review the structure of the cement industry as it affects Atlantic Canada as well as market areas considered relatively accessible to a New Brunswick producer. The proposed study would attempt to identify and forecast market fluctuations and opportunities which could conceivably affect a future decision to reopen the Province's cement plant.

A detailed report is to be prepared reviewing the past, present, and future supply/demand situation for cement and cement products in the Maritimes and immediately adjacent areas of Canada and the United States. The report will include pricing, transportation costs, trends in consumption, identification of market, growth segments and opportunities, products and specialty products in demand, analysis of the industry structure in the Maritimes, an analysis of U.S. trade protectionism regarding foreign imports, and a comparison of existing technology employed in New Brunswick with more modern technology employed in cement manufacture elsewhere.

Output: Final Report submitted.

Funding: Provincial M.D.A.

23. Project: Mineral Fillers Market Review: Potential Implications for New Brunswick

Type: Commodity Study

Year(s): 1987-88

Lead Agency: E.M.R. (Mineral Policy Sector)

Description: Although New Brunswick has had a long history of industrial mineral production, the manufacture of mineral filler products has had a somewhat less than significant impact on the total volume and total value of industrial mineral commodities produced in the Province.

Mineral fillers are finely ground mineral materials used in a wide range of industrial applications as low cost additives to increase the bulk of many commercial products, and usually also to improve or "extend" their physical properties. In 1986, over 10 million tons of industrial minerals valued in excess of $2.5 billion were consumed for extender and filler applications in North America. This represents an average annual growth of just less than 10% since 1981. Growth is expected to continue at a healthy rate for the next five years.

In view of changing technology in some basic manufacturing processes and its impact on mineral filler market growth projections, it appeared prudent to assess the amounts and various types of mineral filler commodities consumed within a market area capable of being supplied by a potential New Brunswick producer.

The primary purpose of this study was to provide a comprehensive and contemporary assessment of the market potential for certain specific New Brunswick industrial minerals used in industrial filler applications. Towards the achievement of this goal, analysis of the current supply/demand of various mineral filler products consumed and produced within a designated market area (reasonably accessible to the Province) was undertaken. The study identified potential opportunities for market penetration, expansion and may provide a basis for possible future development consideration of several indigenous industrial mineral resources. An important part of the proposed study included the purchase of a subscription to a C.H. Kline & Co. Inc.'s multi-client service covering a market review of extender and filler minerals from 1987 through to 1989.

Output: Report entitled: "Extender and Filler Minerals" (not available for distribution) and Open File Report 89-35

Funding: Federal M.D.A. (Purchase of Kline study on Extender and Filler Mineral Markets is jointly funded by the Federal M.D.A.'s of New Brunswick; Nova Scotia and Newfoundland.)

24. Project: New Brunswick Building Stone Promotion

Type: Commodity Study.

Year(s): 1988-89

Lead Agency: E.M.R. (Mineral Policy Sector)

Description: In 1985 a program committed to renewing interest in the utilization of New Brunswick's indigenous decorative and dimension stone resources was initiated. An intregal part of this program has been directed toward resource promotion. This has resulted in the development brochure and a catalogue of finished stone specimens from selected quarry sites located throughout the Province. In order to maximize the exposure these promotional efforts to those individuals or organizations closely associated with using decorative stone products it would seem appropriate to investigate the most effective method(s) concerning its distribution and circulation.

Output: Open File Report 89-43

Funding: Federal M.D.A.

25. Project: Establishment of a Data Base for Granular Aggregate Resources in New Brunswick.

Type: Commodity Study

Year(s): 1988-89

Lead Agency: E.M.R. (Mineral Policy Sector)

Description: The purpose of this project was to compile existing information concerning granular aggregate resources throughout New Brunswick into a computerized data retrieval system to be used as a quick reference guide.

Once thought as ubiquitous substances aggregate supply can be eliminated simply by the stroke of a land-use planner's pen. Given access to pertinent resource information, it is his/her responsibility to develop appropriate control measures to minimize environmental impacts and ensure multiple and post-extractive land use.

Following the recent completion of a mineral aggregate resource inventory program, the Province is now in a position to provide basic quantitative and qualitative information as a guide to these important resources. Even though the inventory program has provided excellent support its effectiveness was hampered somewhat by its ability to provide information in an easily manipulated overview format. This often translated into excessive time and effort required to locate, extract and synthesize existing information when replying to a specific request(s).

The publication of the Granular Aggregate Atlas in 1987 was a positive step towards the consolidation of aggregate data. Although the atlas summarized the genetic type of deposits and indicated their regional distribution, no attempt was made to incorporate pertinent qualitative and quantitative data considered useful in evaluating the relative importance of a particular deposit.

It is of considerable importance to organize the rather extensive aggregate data bank into a more "user friendly" format - a format which can be quickly and effectively searched for relevant information. This approach should ultimately be a more effective support tool to prudent resource management and development and complement the Atlas of Granular Aggregate Resources.

Output: Reference Report 148

Funding: Federal M.D.A.

26. Project: The U.S. Market for Specialty Clays

Type: Commodity Study

Year: 1988

Lead Agency: E.M.R. (Mineral Policy Sector)

Description: A report "The U.S. Market for Specialty Clays" is to be undertaken by Kline & Company Inc., Fairfield, New Jersey. Acquisition of this report will be an important and helpful follow-up for Nova Scotia and New Brunswick to the Metals Economics Group report regarding markets for industrial minerals on eastern United States.

Output: In progress. Report on "The U.S. Market for Specialty Clays" (not available for distribution)

Funding: Purchase of study is shared jointly by the Federal M.D.A.'s of Nova Scotia, New Brunswick and Manitoba.

27. Project: Peatland Resource Management Using SPOT - Demonstration.

Type: Resource Management Strategies

Year: 1988

Lead Agency: D.N.R.E.

Description: To test the feasibility of updating 1:10,000 maps of production bogs using SPOT satellite imagery.

A 1:10,000 map is to be prepared outlining the aerial extent of a typical production bog, its associated drainage net and pertinent land management information (property boundaries, field in production and abandoned, roads, buildings).

Such an approach should be useful in production bog maps facilitating proper management of the resource by the Province.

Output: Final report submitted.

Funding: Provincial M.D.A.

28. Project: Information and Technology Exchange - Industrial Minerals.

Type: Commodity Studies

Year(s): 1987-88

Lead Agency: E.M.R. (Mineral Policy Sector)

Description: Appropriate funds were secured, enabling qualified DNRE personnel to attend and participate in the 8th Industrial Minerals International Congress at Boston, Mass. in April, 1988.

In order to remain well informed and competitive in the rapidly developing field of industrial minerals, it is extremely important that the Province pursue every available opportunity:

- to promote efficient development of it indigenous industrial mineral resources.
- to learn through the experience of others the most effective and efficient means of resource development.
- to be able to assess future trends in market demand for certain industrial mineral commodities including adding value to and improving the quality of those currently produced in the Province.

The 8th International Industrial Minerals International Congress offered a unique opportunity for contemporary information and technological exchange from and international team of experts, regarding a wide range of industrial mineral commodities and related issues. A symposium of such calibre, specifically related to industrial minerals is an exception rather than the rule. It offered discussion of a variety of topics including new projects, new applications, market demands and new developments in process technology - all considered highly relevant to industrial mineral resource development in New Brunswick.

Output: International exposure and distribution of appropriate literature introducing and promoting investment opportunity in New Brunswick, particularly regarding industrial minerals. A report on the symposium and proceedings was secured.

Funding: Federal M.D.A.

29. Project: Aggregate Market Study for New Brunswick and Nova Scotia

Type: Commodity Study

Year(s): 1987-88

Lead Agency: E.M.R. (Mineral Policy Sector)

Description: While a relatively low value product, aggregates are a valuable resource because of the very large volumes used. Thus, the production and marketing of aggregates can be a significant contributor to a region's economy.

Aware of the economic potential and importance of aggregate development, the Governments of Canada, New Brunswick and Nova Scotia have sponsored a number of studies on the aggregate industries in New Brunswick and Nova Scotia.

This report is from one of those studies.
Volume I describes the market for aggregate materials within New Brunswick and Nova Scotia including production and consumption information. Among the topics covered were:

quantities of aggregates produced (type, processing)
value of product
cost of production (profile, unit)
aggregate specifications
survey of producers
directory of producers
quantities of aggregates consumed (type, product)
value and price
consumer specifications
survey of consumers
directory of consumers
aggregate distribution

The Volume II presents projections of the future market for aggregates in the two provinces. Included are reviews of the aggregate resources, projected aggregate demand, and discussion of trends and developments which could affect aggregate demand.

With this report, producers, consumers, and others involved in the industry should be able to obtain a general overview of aggregate markets in New Brunswick and Nova Scotia. It is hoped that this information will allow participants in the aggregate industry to anticipate developments and plan strategies for handling future conditions.

Output: Open File Report 88-19, 20, 21

Funding: Study was jointly funded from Federal M.D.A.'s of New Brunswick and Nova Scotia

30. Project: Compilation of Information of Surficial Mineral Resources off Eastern Canada

Type: Commodity Study

Year(s): 1987-88

Lead Agency: E.M.R. (Mineral Policy Sector)

Description: The project was initiated to provide a nearshore data compilation that could be used to help plan non-fuel mineral exploration programs. It is also intended to serve as a first step towards the preparation of integrated resource planning maps that will identify areas with mineral potential relative to areas of possible fisheries and environmental concerns.

Output: Reference copy available

Funding: Study was jointly funded from the Federal M.D.A.'s of New Brunswick, Nova Scotia, Newfoundland and Prince Edward Island.

31. Project: Peatland Reclamation - Phase II

Type: Resource Management Strategies

Year(s): 1989-90

Lead Agency: D.N.R.E.

Description: This project will test peatland reclamation options identified in an earlier MDA Project (Peatland Reclamation - Phase I) by conducting field evaluation of selected abandoned sites on production bogs, preparing reclamation plans, and performing site preparation. The initiation of field tests should ultimately lead to the development of Provincial guidelines for reclamation of abandoned peat moss production bogs.

Output: In progress

Funding: Provincial M.D.A.

32. Project: Information Booklet, re: Industrial Minerals in New Brunswick

Type: Economic Development

Year(s): 1989-90

Lead Agency: E.M.R. (Mineral Policy Sector)

Description: Most would associate mineral development in New Brunswick with extensive base-metal mining operations situated in the northern part of the Province. Few people seldom either realize or simply take for granted a category of mineral commodities they see and use everyday - mineral commodities that are directly associated with virtually every activity of our modern life style. These mineral substances referred to as "industrial minerals", are the "workhorse minerals", - minerals upon which much of our economy and personal well being depend. Our lives would be very much different without ready, economical access to these fundamental mineral commodities.

Despite their importance these essential ingredients of civilization are largely ignored. The apparent low profile of industrial minerals in New Brunswick and most other places, is considered to be a function of the numerous stages of transformation these substances undergo in making them a suitable consumer item. Unlike metals which are easily recognizable in most consumer goods, industrial minerals are often camouflaged in compounds that in most cases entirely mask their origin. The next time you pick up something made of paper, plastic or even rubber, just take a moment and consider that these particular products would not be possible to manufacture cost effectively or would vary considerably in quality if it were not for industrial mineral derived products.

In light of a perceived deficiency in public awareness regarding industrial minerals, a bilingual information booklet is to be produced acknowledging and describing the importance of these substances in today's society, with special reference to those presently produced in New Brunswick, those which have been produced and those which may deserve evaluation in the future. The booklet is intended to bring together information both of general and semi-technical nature so that these resources and their inherent uses may be better understood and appreciated.

Output: In progress

Funding: Federal M.D.A.

II. MINING AND MINERALS TECHNOLOGY PROGRAM

1. Project: Process Evaluation of Selected Options for Treating New Brunswick Manganese Mineral Deposits.

Type: Mineral Processing

Year(s): 1985-1988

Lead Agency: E.M.R. (Canmet)

Description: Although there is apparently considerable manganese in Canada, nevertheless it is not exploited but is imported. New Brunswick has many known occurrences of manganese mineralization. Sampling, chemical and mineralogical analyses followed by bench testing of several possible metallurgical processes was evaluated. Finally the selected process (or processes) was to be run continuously on a sufficiently large scale to obtain mass, water, and energy balances, to determine process economics and feasibility.

Outputs: Open File Reports (Vol. I) 87-12 and (Vol. II) 87-13

Funding: Federal M.D.A.

2. Project: Alkali Reactivity of Potential Concrete Aggregates of New Brunswick.

Type: Resource Evaluation.

Year(s): 1985-90

Lead Agency: E.M.R. (Canmet)

Description: The potential reactivity of possible New Brunswick aggregate materials when emplaced in portland cement concrete is to be determined. Concrete structures in the Province, principally those on highways and in buildings in most environments, have shown evidence of deterioration arising from reactions between certain silicious or carbonate aggregates and the alkali constituents of cement. The project is intended to provide necessary information on the stability of aggregate materials identified in Province to guide use in potentially destructive environments. Selected N.B. aggregate deposits are being evaluated for potential cement-aggregate reactivity. Engineering data is being developed to help control such deleterious reactions.

Studies of degraded N.B. concretes and characteristics of the aggregate materials used are being reviewed.

Aggregate material in the field is being examined and samples are being gathered for petrographic classification and testing of their alkali reactivity.

Output: In progress (draft of final report submitted for review)

Funding: Federal M.D.A.

3. Project: Mineralogical Studies of Potash Deposits.

Type: Mineral Processing

Year(s): 1985-90

Lead Agency: E.M.R. (Canmet)

Description: The mineralogy of the potash ores in New Brunswick is to be determined and the properties that affect beneficiation of potash minerals are to be characterized. This will involve identifying the minerals in ores and potential ores, and determining the size distributions of the potash minerals to predict liberations and recoveries. This will be augmented by studying mill products from potential ores and from operating plants to help define operating conditions for most efficient operations.

Output: In progress (final report submitted)

Funding: Federal M.D.A.

4. Project: Use of Backfill in New Brunswick Potash Mines.

Program: Mining and Minerals Technology.

Type: Mineral Processing

Year(s): 1985-90

Lead Agency: E.M.R. (Canmet)

Description: The stablizing effect of waste salt as backfill on mine openings in potash mines is being evaluated with the purpose of improving the capability of predicting ground behaviour resulting in increased safety and maximum potash extraction.

Output: In progress

Funding: Federal M.D.A.

5. Project: Evaluation of Ecological Constraints on Peat Mining

Type: Mining and Minerals Technology

Year(s): 1989-90

Lead Agency: D.N.R.E.

Description: The potential impacts of peat bog mining on the ecology of eastern New Brunswick are becoming an environmental issue, especially regarding the effects on water quality and on moose habitat and their population. These issues now reflect a significant constraint in the development of the peat industry. This study was proposed, therefore, as an avenue for obtaining base-line data on the hydrology and moose population of the Escuminac Bog Complex, to demonstrate quantitatively the environmental impacts, if any, of peat mining. Such quantification should aid in the development of suitable guidelines regulating such impacts, if warranted.

Output: In progress

Funding: Provincial M.D.A.

III. PUBLIC AWARENESS PROGRAM

Project: Technical Information Seminar on Peat

Type: Public Awareness

Year(s): 1989

Lead Agency: D.N.R.E.

Description: A seminar was organized and held at Shippagan on March 1989 to provide technical information to New Brunswick peat producers. Experts presented briefs pertaining to quality control, marketing, new manufactured peat products, plant management, and mining equipment.

Output: Open File Report 89-33

Funding: Jointly funded by Provincial and Federal M.D.A.

IV. MINERAL INVESTMENT STIMULATION PROGRAM (MISP)

The MISP was initiated in 1986 as grant program aimed at promoting development of the Province's mineral resources by providing financial assistance to industry for specific projects. Although the program is Federally funded, it is administered by the Department of Natural Resources and Energy.

Since its inception, it has gained widespread acceptance amongst the mineral industry largely because of its industry-driven component. Basic conditions of the program are that the applicants must be developers or operators having mineral rights within the Province and that Provincial project funding shall not exceed 50% of an approved project to a maximum to $50,000 per project. Examples of eligible project areas include characterization or extension of "an established mineral deposit" and marketing and processing studies of mineral concentrates. Further details may be found in the MISP brochure, available through the Mineral Development Branch.

Below is a summary of the objectives of each of the approved industrial mineral-related projects. Note that the status and results of these projects are not discussed. There is a two-year confidentiality period on all MISP projects:

Company	Project Objectives
1. Maritime Resource Research Ltd.	To further characterize the Plymouth manganese deposit near Woodstock, N.B.
2. Eastern Gypsum Inc.	To survey selected N.B. gypsum deposits as a feedstock for a proposed wall board manufacturing plant at McAdam, N.B.
3. Dickenson Mines Ltd.	To extend reserve base of limestone deposits in the Havelock, N.B. area.